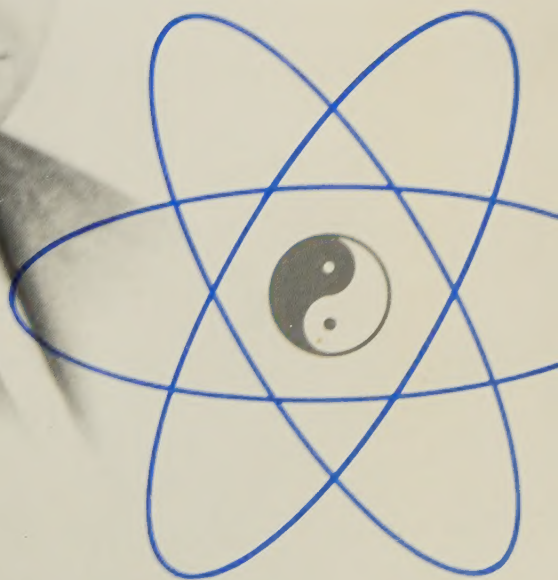


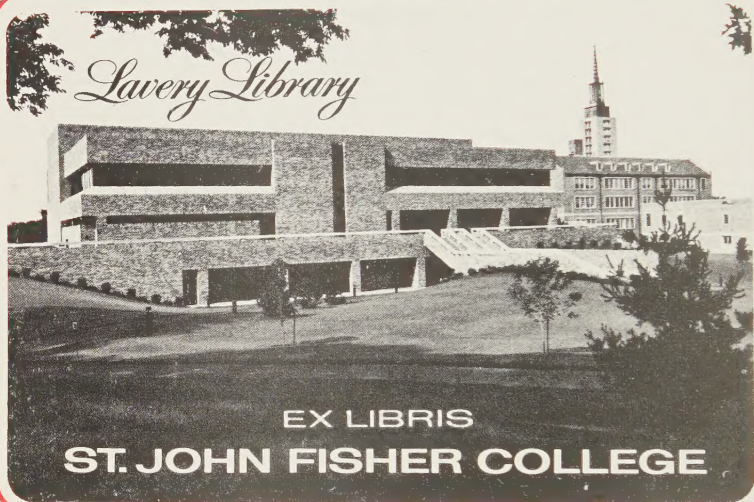
K.V. Laurikainen

Beyond the Atom

The Philosophical Thought of Wolfgang Pauli



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Wolfgang Pauli

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To My Faithful Fellow Combatant,
My Wife Aila

Foreword

This book is mainly based upon a study of correspondence. A letter is not comparable to a scientific publication. The wording in a letter is not as polished as it would be in a research paper. On the other hand, a letter is more open. Ideas can be presented which are not yet ready for publication, and for just that reason letters can substantially illuminate the background of a scientific work.

The correspondence between Wolfgang Pauli and Markus Fierz is a rare collection of documents which guides us to the deepest sources of these physicists' thought. In this way the fundamental philosophy of modern physics attains quite new enlightenment. Here physics joins the universal currents of contemporary thought. Pauli's letters have something to say to the philosopher, idea historian, theologian, biologist and psychologist – and to the average person of our time who is searching for answers to the basic questions of existence.

The correspondence between Fierz and Pauli is quite extensive – despite the fact that a great portion of their letters have been destroyed. They deal with many different kinds of questions, for which reason Pauli's philosophical attitude can be understood much better in their light than by reading his very concise publications.

Pauli's letters do not unfold in a moment, however. When one reads a letter again, many details often appear more interesting than they did at the first reading, and when it is studied for the tenth time, one may feel that only then has the full meaning of the words begun to clarify.

This book should be classified as a book in popular science. I have tried to make Pauli's philosophy understandable to an average academic reader, not only to the scientist. I want to arouse interest in this unknown side of Pauli's personality. For this purpose I have mainly sought to find my own expressions for describing Pauli's thought, although I well understand the danger in this. The interpretation of a genius has its difficulties, and undoubtedly someone else may decide on another description regarding certain details. Pauli's own expressions often presuppose more knowledge in quantum mechanics or in the history of ideas and in philosophy.

I am grateful to the late Mrs. Franca Pauli and to Professor Markus Fierz, as well as to the Pauli Committee which is responsible for the use of the Pauli Letter Collection at CERN, for the permission to publish rather long quotations from the Pauli letters. Without this possibility of letting

Pauli speak for himself, particularly in matters of sensitive nature, it would not be possible to give a trustworthy picture of Pauli's thought. I hope that these excerpts from his correspondence are sufficient for giving an authentic impression of it.

During the long period of time over which I have tried to learn to understand details in the Pauli letters, I became more and more convinced of the importance of Pauli's philosophy for our time. I have found it necessary to try to illuminate it more in detail than the excerpts of letters directly express. I have done this in Chapter X which contains my personal way of describing Pauli's conception of reality.

Already the title of this Chapter, "Transcendental reality" may arouse criticism. The term "veiled reality" used by B. d'Espagnat would perhaps be better, but it could emphasize the similarity of the concepts of reality of these two great thinkers too much. Both of them – as far as I understand it – consider reality to be, in a similar sense, outside the range of our rational knowledge. I understand the "irrationality" of reality which Pauli emphasizes and the fact that reality remains "veiled" for us, as d'Espagnat describes the situation, in a very similar way indeed. In order not to use the same term as d'Espagnat, however, I have coined here the term "transcendental reality". I do not mean "transcendental" in the sense of the Kantian "thing-in-itself" (*das Ding an sich*), because every experimental scientist believes that empirical research is able to attain some knowledge of the structure of reality. It does not reach, however, reality itself and not even approach it in an asymptotic sense, just because of the irrationality of reality. In this sense reality remains "transcendental" for us.

My description of Pauli's philosophy may be to some extent one-sided as I have wished in particular to clarify ontological aspects which I find to be most interesting in Pauli's thought.

In the appendices I have tried to describe in more detail the epistemology and ontology implied in Pauli's letters. Appendix I emphasizes an important difference between Bohr and Pauli with respect to the role of the observer in microphysics. Appendix II tries to illuminate the same thing further. In fact, as I understand Pauli, he would not agree with the basic philosophy in several attempts to clarify the logical structure of quantum mechanics, characteristic of the foundational research of quantum theory since the sixties. Appendix III is an attempt to describe the philosophy of microphysics as I understand it, after thinking a great deal about Pauli's letters. It is a very personal description of these matters, and I can only state that according to my personal judgement it describes something at the very heart of Pauli's philosophical thought. A future analysis of Pauli's letters will show whether this belief is justified.

It is time to open a discussion concerning Pauli's philosophy. Quite a lot has been written about the philosophical thought of Einstein and of Bohr, while people do not seem to know at all that Pauli had deep philosophical views which differ essentially from those of standard scientists and philosophers today. However, in the future Pauli may be found to have been the

deepest philosopher of these three. His philosophy is close to Bohr's but Pauli is clearer and more consistent.

This book is just a beginning in this field. Certainly there will be others who will continue this work, and probably details of my presentation will have to be corrected. I hope, however, that I have not essentially misunderstood the main features in Pauli's thought which I have studied over a very long period – since 1976.

In order to understand Pauli's thought, it is necessary to take particular note of his *quaternarian* attitude, especially in his later years. This is described in Chapter IX, and it can be preliminarily characterized as putting emphasis on the intuitive comprehension of *wholeness* instead of the exact details. The general trend in science today is towards specialization which is based on a "trinitarian" world view. Among the founding fathers of quantum theory, Niels Bohr was clearly a quaternarian thinker while Dirac, in particular, represented trinitarian thought. It is exactly this "quaternarian" basic attitude which makes Pauli so interesting and timely today.

Because the Pauli-Fierz correspondence is the best source for the study of Pauli's philosophical views – or let us say Pauli's philosophy – the complete publication of this correspondence, as soon as possible, must be considered a matter of importance. It also contains, in a most consistent form, the philosophy which is the basis of the Copenhagen interpretation of quantum mechanics. I have tried to show this in Appendix I, "Wolfgang Pauli and the Copenhagen Philosophy", which contains a lecture given at the Symposium on the Foundations of Modern Physics: 50 years of the Einstein-Podolsky-Rosen Gedankenexperiment, held in Joensuu, Finland in June 1985.

One characteristic of Pauli's thought is that he considers drawing a sharp border between science and religion or science and metaphysics to be very dangerous. This is one thing which makes Pauli's philosophy very timely – in contradistinction to the standard attitudes regarding philosophy and world views.

This attitude, however, is not quite clear for me even yet. Pauli went through a time of deep crisis when he was about thirty years old, one expression of which was his separation from the Roman Catholic Church. Pauli became a free-thinker – even in a legal sense. Nevertheless, he often emphasizes the objective significance of the attitude complementary to that in natural science. What this really means will, it seems to me, remain an open question. The maturation process which Pauli's thought went through was ended by an untimely death.

Science was Pauli's starting point in these questions also. The message of particular importance which he has for modern man is that an unbiased delving into the foundations of science can guide the researcher to an understanding of the significance of religion.

The general trend in the investigation of the philosophical implications of quantum theory after the death of its founding fathers has been towards *realism*. There are differences in the more detailed characterization of this trend but the common aim has been to describe the "outer world" as independent of the "observer". One thinks of a universe where human beings

and human psyche exist just as *results of the evolution* which follows its "objective" laws quite independent of the existence of any "observer".

Pauli was critical with respect to such ideas. Basic to his world view is the inseparable union of spirit and matter. In a letter to Fierz (PLC 0092.200; March 5, 1957; cf. p.73) Pauli mentions his agreement with some ideas of the German zoologist B. Rensch:

Insbesondere meint R[ensch], die "psychischen Parallelkomponenten" konnten doch unmöglich in der sonst stetigen Ontogenese "plötzlich aufgesprungen" sein. Also müsste schon die sogenannte unbelebte (nicht-organische) Materie "schwache psychische Parallelkomponenten" aufweisen. Diese Schlussfolgerung schien mir vernünftig . . . [R. means especially that it would be impossible, however, for the "psychic parallel components" to have "suddenly emerged" in the otherwise continuous ontogeny. Therefore even the so-called lifeless (non-organic) matter should show "weak psychic parallel components". I found this conclusion to be reasonable . . .]

In another letter to Fierz Pauli writes that when, in the process of the chemical evolution, an organic molecule which was able to duplicate itself emerged for the first time, how could one say that psyche was not present at that moment. (PLC 0092.107; no date.)

Pauli describes the relations between matter and spirit, and between physics and psychology respectively, as complementary. It was a very fateful separation which Descartes made in the 17th century between spirit (*res cogitans*) and matter (*res extensa*), although it was understandable at the time. This misconception still dominates Western thought. In physics it appears in the idea of the "detached observer": it is assumed that the influence of the observer on the observed phenomenon can always be eliminated, in principle. Niels Bohr also accepted this idea in his later years, while Pauli saw in quantum mechanics a "road sign" in another direction; one should not neglect the influence of the human psyche on observations.

The difference between Bohr and Pauli in their philosophical attitudes will be discussed later (p.51). The question of the "detached observer" is characteristic in this respect. In general Bohr and Pauli understood the questions of the interpretation in quite the same way, viz., in the sense of the complementarity philosophy of Bohr.

The idea of the "detached observer" is characteristic of the materialistic world view which subordinates the spiritual component of reality to the material one. The idea of the *anima mundi*, the world soul, has been completely expelled from the scientific world view. The indeterminism of the atomic world gave Pauli reason to speak of the return of the *anima mundi* (in a new sense of the word).

When Niels Bohr chose the Taoist Yin-Yang symbol for his coat of arms in the Danish Elephant Order, he was no doubt aware of the essential role of spirit in the Taoist conception of reality. Any kind of mysticism was, however, strongly against his basic attitude. Therefore Bohr's conception of real-

ity became unclear, and his attitude has been generally interpreted as corresponding to positivism (or instrumentalism).

Pauli was more consistent. According to him it is wrong to imagine the existence of the material "outer world" without including the "observer" and his psyche in the world view. The idea of a "detached observer" and the trend towards realism – in the usual sense of this word – has to be abandoned. According to Pauli, *spirit and matter must be considered as the two complementary basic elements of reality*.

Heisenberg's view of the role of the observer was rather close to that of Pauli but less definite. He gives a review of the interpretational problems of quantum mechanics, e.g., in the article "Die Entwicklung der Deutung der Quantentheorie" (The Development of the Interpretation of Quantum Theory), *Physikalische Blätter* 12, 289–304 (1956). Heisenberg describes the role of the observer implicitly with the aid of the "Aristotelian" concepts of *potential* and *actual*. This difference is an expression of the limitations of our psyche when attempting to comprehend reality, and it is intimately connected with the fact that only statistical laws are possible in microphysics.

The mathematical description of the atomic world and especially its *wave function* relate to the *potential* attributes of the microworld. The actual properties of this world are expressed in the experimental data which are described by using the macrophysical language (i.e., in a language which concerns an "objective" world where objects have "objective properties" independent of observations, quite as the idea of the "detached observer" presupposes). In the observation some of the potential properties of the object "become actualized", something formally expressed in the "reduction of the wave packet".

This difference between the potential and the actual level of our knowledge is an expression of the psychological limitations of the human observer. At the end of his article Heisenberg pointed out that we have certain "*a priori*" limitations in our comprehension of the world. Therefore the microworld can be described only in the sense of the "potential" level whence the wave functions, in particular, cannot be considered as "actual elements of reality" as the materialistic philosophy would like to understand them.

Heisenberg did not describe the implications of this situation with respect to our conception of reality as clearly as Pauli did. The former speaks, however, of the essential role of psyche in the quantum mechanical conception of reality, and in several articles Heisenberg has emphasized that the Copenhagen interpretation is not compatible with a materialistic world view. Heisenberg interpreted the state function as "our knowledge" of the state of the system. Pauli still more clearly emphasized the indeterminism /statistical laws in quantum mechanics and the fact that this leads to the conception of the *irrationality of reality*. He associated this with the unconscious functioning of our psyche. Therefore empirical science cannot be isolated from psychology. The objectivity of human knowledge appears to be a utopian ideal, and scientific knowledge cannot be strictly separated from subjective beliefs. This is a consistent explication of the complementa-

rity philosophy which Bohr himself did not dare to develop in all its consequences because of his strong aversion to mysticism. In this respect Pauli has been the most critical and most consistent among the founding fathers of quantum theory.

Heisenberg finished his article on the development of the interpretation of quantum theory (Phys. Blätt. 12) with the following paragraph:

Da alle bisherigen Gegenvorschläge zur Kopenhagener Deutung sich gezwungen gesehen haben, wesentliche Symmetrieeigenschaften der Quantentheorie zu opfern, wird man wohl annehmen können, dass die Kopenhagener Deutung zwangsläufig ist, sofern man diese Symmetrieeigenschaften, ähnlich wie die Lorentzinvarianz, für einen echten Zug der Natur hält; und dafür sprechen bisher alle Experimente.

[Since all counter proposals to the Copenhagen interpretation presented so far have found it necessary to sacrifice essential symmetry properties of quantum theory, one may perhaps assume that the Copenhagen interpretation is necessary, as far as one considers these symmetry properties, in analogy with the Lorentz invariance, to be a genuine feature of nature; and all experiments until now support that.]

In this respect Pauli certainly agreed with Heisenberg: all counter proposals to the Copenhagen interpretation have been less satisfactory. In order to clarify Pauli's thought I shall try to show why certain wellknown competing proposals are less satisfactory than the Copenhagen interpretation if we accept Pauli's conception of reality.

The Ensemble Interpretation (also called the "Statistical Interpretation")

In this interpretation the basic concept is not an individual atomic system but an *ensemble* of similar systems in the same state. The state function refers to such an ensemble of systems, not to an individual atomic system, and this ensemble must be "sufficiently large", in principle infinite. Several authors maintain this interpretation to be just a clarified version of the original statistical interpretation, i.e., of the Copenhagen interpretation. Einstein seems to have been inclined to accept the ensemble interpretation, and his collaborator *N. Rosen* has described it as the most satisfactory interpretation of quantum mechanics.

The principal weakness of the ensemble interpretation is that it cannot describe *individual* atomic events at all. According to Pauli, the irrationality of reality becomes apparent specifically in individual experimental events. If we accept the ensemble of similar systems in the same state as the fundamental concept, we exclude a basic *irrationality* from reality and limit our thought to the rational features of reality only. This attitude corresponds to the general "repression of irrationality" characteristic of Western thought, which Pauli repeatedly criticizes.

Pauli could not accept this repression, and therefore he found it essential that the state function be associated with an individual atomic system, not

with an ensemble. This is based on a philosophical standpoint of uttermost importance, concerning the nature of reality. Taking a stand on this question has an influence on the direction of the future development of the theory.

One can also say that the concept of an "ensemble of similar systems in the same state" is not a clear concept before we know how we can "prepare similar systems for the same state". When describing this we must first speak of individual systems and of their states, and therefore the concept of an individual system and its state is more fundamental than the concept of an ensemble of such systems. Thus it is clearer to associate the concept of state, described by the Ψ -function, with an individual system than with an ensemble.

"The State Function of the Universe"

In several interpretations of quantum mechanics it is assumed that the universe in its entirety can be described with the aid of quantum mechanical formalism. Thus, one speaks of the state function of the whole universe. This idea is explicitly based on the conception of an autonomous "outer world" which can be described without speaking of any "observer" (i.e., on the idea of a detached observer).

This idea of a "state function of the universe" is impossible according to the conception of reality which Pauli had, and in a more general sense, it is not compatible with the philosophy of the Copenhagen interpretation. Bohr used to emphasize, especially in his later years, that a "phenomenon" must be understood as a *whole* which includes both the object system to be described and the instruments used for the observation of the "phenomenon". Here the "instruments" contain both the instruments used for the preparation of the object system for a definite state described by the state function and the instruments used in the registration of the results.

This conception of a "phenomenon" is basic to Bohr's view concerning quantum processes. The idea of the "wave function of the universe" presupposes an extrapolation of the quantum mechanical description into a case which is not compatible with Bohr's philosophy. It is even more in contradiction with Pauli's thought because the essential role of the human psyche in the world view is neglected.

A straightforward consequence of this idea is to conjecture that the human psyche can also be described with the aid of a state function. Such an idea is based on a materialistic conception of reality, and it is in complete contradiction with Pauli's thought – and with Heisenberg's thought as well, as far as I understand it.

The concept of the state function of the universe is used, e.g., in the *many-worlds interpretation* of Everett and DeWitt. I cannot imagine Pauli taking this kind of speculation seriously. The materialistic conception of reality seems to create very strange views when combined with quantum theory; the real nature of the observational problems in atomic physics has in this case become distorted into an absurdity.

The Indivisible Wholeness of David Bohm

Bohm is a typical representative of those people who find the Copenhagen interpretation to be unclear. He developed in the fifties a *hidden variable theory* based on an idea which de Broglie also had proposed in the twenties. Characteristic of Bohm's theory is that it contains long-distance "influences" of a new kind. Because of them, the world becomes an *indivisible wholeness* in which everything more or less influences everything.

Bohm wishes to describe microphysical particles as "ordinary objects" with attributes (also kinematic attributes) independent of observations. This is in agreement with the idea of a detached observer.

Bohm accepts the use of the wave function (state function) of ordinary quantum mechanics and its derivation from the Schrödinger equation. This function, however, is interpreted as a *new kind of field* which influences the mechanical behaviour of the particles in the system with which the wave function is associated. It is then also possible to define exact position coordinates and momenta for these particles and speak of their definite orbits.

By interpreting the wave function as a new kind of "field" – which in a many-particle system is not a field in the three-dimensional space but in the multidimensional "configuration space" of the system – Bohm thus introduces a new kind of "influence" which is independent of space and time and refers to the "wholeness" of the system and its neighbourhood

Due to the limitations characteristic of the microphysical observations, only statistical predictions are possible with respect to observations. These predictions in Bohm's theory are exactly the same as those in ordinary quantum mechanics. In this sense he just gives a new interpretation for quantum mechanics. Bohm, however, speaks of his hypothetical orbits and kinematical attributes as belonging to a new level of reality where it is possible to describe the change in the state of the system in a strictly causal manner, not just in a statistical sense as in ordinary quantum mechanics. In this sense he has a *new conception of reality*, and in fact he is developing a new theory which could even lead to new experimental predictions, if the hypothetical level of definite orbits would in the future become attainable through experiment.

The psychological problems associated with observations are quite neglected by Bohm, not to speak of the manifestations of the unconscious! In his causal-deterministic universe Bohm does not see any "quantum mechanical paradoxes" – but there is no place for free will either, at least not without postulating a still deeper level of reality. Theory of measurements becomes a causal play between the robot-observer, his causal instruments and the observed system, without any "collapse of the wave function". Even the universe as a whole is understood as a quantum mechanical system.

The problems concerning human knowledge which make the Copenhagen interpretation so revolutionary – especially if it is understood in the sense of Pauli's conception of reality – have in Bohm's reality disappeared. This is no solution to these problems but a way to avoid seeing them. Bohm constructs a world view which avoids discussing the basic problems of empirical knowledge and the role of psyche in the world.

It is interesting that Bohm, however, also describes human psyche in recent publications, and has, in fact, found parallels to Eastern mysticism in his "quantum reality". The dualism of matter and spirit is in his world view related to the dualism of particles and waves, which are considered to be the basic constituents of equal standing in Bohm's world. There are also other important features in Bohm's world view which bear similarities to Pauli's conception of reality. For instance, Bohm also emphasizes *wholeness*, not only in microphysical situations but more generally, and he also finds that "*influences*" which are independent of space and time are needed in microphysics. Further, he finds it necessary to reconsider the *psycho-physical problem* which Pauli emphasizes as the most important problem of our time. Because Bohm comes to similar conclusions to Pauli concerning these important questions, despite the fact that Bohm is searching for a new conception of reality in quite another way than Pauli, it may be concluded that quantum mechanics is in these questions a road sign in a definite direction.

Perhaps this comparison of Pauli's views with those of some others makes it easier for the reader to understand my account of Pauli's philosophical thought. It must be emphasized that Pauli's message is revolutionary. He had the distinct opinion that the general trend of Western culture after the 17th century has been one-sided and dangerous. One can characterize it as a vision of a clock-work universe – a deterministic world where everything is, in principle, predestined. This vision has created a materialistic culture where the influence of religion has continuously diminished, and of which a strict separation between science and religion is characteristic. Pauli wishes to give us a vision where *spirit* has again been acknowledged as a basic element of the world along with matter. The universe should again be seen as an *organism*, not a clock.

The Copenhagen interpretation of quantum mechanics was, for Pauli, a "road sign" into this new world which is characterized by the *complementarity of spirit and matter* – and of religion and science. The view which Pauli opens is not bound to Eastern religions – although he also mentions the East-West problem in this connection. The West should find a Western way for putting in concrete terms the vision of a new world which Pauli opens. There is a very strong opposition in the Western academic world against allowing any *irrationality* in the picture of the world. This is the case both in science and in religion. This *repression of the irrational* is what we have to overcome in order to see the perspective which Pauli seeks to open to us.

I wish to acknowledge the financial support which has made my work with Pauli's letters possible. It has been granted by the Academy of Finland, partially through the Particle Physics Committee which has funds for collaboration with CERN. During my visits to CERN, I received very much help from the Scientific Information Service group, especially from Dr. A. Günther and Dr. Roswitha Rahmy. In addition, Professor Markus Fierz and

Professor Charles Enz have made valuable remarks concerning my manuscript and the German quotations. I am very grateful for their assistance. In some cases the interpretation of Pauli's handwriting and the checking of its grammatical form would otherwise have been extremely difficult for me.

The translation of my book into English was also made possible by awards granted by the Academy of Finland. Ms. Carol Westerlund, M.S., did the translation from Finnish to English, with my assistance. She has had a very tough job finding expressions which would also satisfy my (often insufficient) comprehension of English words and expressions. It has been valuable to have a translator who is herself specializing in the philosophical questions of quantum theory in her own studies. Ms. Westerlund has also produced a camera-ready text for the book with the aid of a word processor. Appendix IV, which contains translations of the German quotations into English, has been produced by Mr. Eugene Holman, M.A. In addition, his assistance with the final word processing is also gratefully acknowledged.

For several years I have arranged regular seminars where questions discussed in this book have been thoroughly debated. I owe very much to the participants in these discussions.

To my publisher, and especially to Professor W. Beiglböck, I am grateful for their kind interest and criticism which has influenced not only the appearance but also the contents of the book.

Finally, I wish to express my thanks to my wife who – in spite of health problems during recent years – has always inspired and supported me in my work.

Klaukkala, September 1987

K.V. Laurikainen

Some additional information concerning Pauli's philosophical thought can be found in "Symposium on the Foundations of Modern Physics 1987: The Copenhagen Interpretation 60 years after the Como Lecture"; Joensuu, Finland, 6–8 August 1987 (eds. P. Lahti and P. Mittelstaedt; World Scientific Publishing Company, Singapore, 1987). A report on the discussion sections of the same Symposium have been published as a special booklet in the theoretical physics series of the University of Turku (eds. P. Lahti, K.V. Laurikainen, and J. Viiri).

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The kernel of the Copenhagen school: *Niels Bohr*, *Werner Heisenberg*, and *Wolfgang Pauli*.

(By permission of the Niels Bohr Archive)

Introduction

In early December 1958, the lecture of Wolfgang Pauli, Professor of Theoretical Physics at the Technical University in Zürich (ETH), was interrupted because Pauli had intense pains. These proved to originate from an untended illness, by then already in an advanced stage of development. Ten days later, on December 15, 1958, Pauli died at the Red Cross hospital in room number 137.

The prime number 137 had continuously occupied Pauli's mind. It is an approximate value for a constant appearing in the fine structure theory of atomic spectra which in its theoretical expression ties together electromagnetism, relativity and quantum theory. Pauli saw the fine structure theory of spectra as a key in understanding the deepest contemporary problems of theoretical physics. For that reason the number 137 possessed a mysterious attraction for him.

When Charles Enz, Pauli's assistant at the time and currently a professor at the University of Geneva, came to visit his teacher at the hospital Pauli asked whether he had noticed what the room number was. I suppose Pauli took it to mean that the mystery would soon be revealed to him.

Death cut short Pauli's systematic work on the foundations of the philosophy of physics. Particularly after World War II, Pauli had dug deeper into it than is generally known. Only a few short articles remained as a printed witness of this unusually many-facetted research work. And because these articles were written in German, Pauli's ideas are surprisingly unknown. They sharply deviate from the positivistically-oriented stand which generally characterizes a physicist's thought.

It is important that Pauli's philosophical ideas become better known, for they can be a particularly interesting contribution to philosophical discussion. In his book *Roots of Coincidence*, Arthur Koestler has stated that Pauli had "perhaps a deeper understanding of the limits of natural science than did most of his colleagues".

I must concur with this view, on the basis of my acquaintance with the Pauli Letter Collection at CERN (The European Nuclear Research Organisation). Pauli grasped the meaning of the philosophy of atomic theory even more clearly than did the famous founding father of atomic theory himself, the Danish Niels Bohr.

The publication of Pauli's letters is now underway. Two thick volumes are ready and a third is being prepared. However, it will take quite a bit of time before the volume concerning the most interesting period of the fifties (from a philosophical point of view) will be published. This book attempts to give some kind of preliminary picture of Pauli's philosophical thought. To begin with we shall take a few glimpses to see what kind of matters are at question here.

I am particularly interested in the correspondence between Pauli and Markus Fierz, then Professor of Theoretical Physics at Basel University. This exchange is very broad and deals mainly with philosophy and history of ideas. One has to admire the style of the writers just as much as their expertise. The message of Pauli's short epistemological articles gains an added depth and clarity on the basis of this correspondence.

Beginning the Profession

When he was 19 years old, Pauli got a rare assignment. He was asked to write an entire encyclopedia volume on relativity theory. The result was excellent, and Einstein himself has praised it as being truly exceptional. When Pauli was later asked how it was possible for him when only 20 years old to complete this huge project, thereby demonstrating his complete command of the literature on relativity theory, he responded: "Well, I was a child prodigy." During his school days and in his first year at the university he read everything written about the theory of relativity. In his critique, Einstein also mentioned that Pauli's review showed an exceptional critical faculty as well as a rare sense of style.

Pauli's own scientific work, however, dealt primarily with quantum theory, that is, the basic theory of atomic physics, and not with the theory of relativity. He got his physics diploma at a time when atomic physics was reaching a boiling point. Bohr's atomic model had proved to be unsatisfactory and it became necessary to look for new roads into the atomic world. Copenhagen was the leading center in the task.

Bohr invited Pauli there for the academic year of 1922-23, and a younger university colleague of Pauli's, Werner Heisenberg, for 1924-25. This triad's contribution proved decisive--particularly from the point of view of philosophy--for the "sailing into a new world" which took place in atomic physics during 1924-27.

Einstein's Spiritual Son

Pauli had a complete mastery of physics. His criticism came to be relied upon whenever it was necessary to take a stand on a new matter. He was

called "the conscience of physics" because his crushing critiques prevented research being directed at matters of secondary importance. Einstein held Pauli in high esteem. When Pauli was awarded the Nobel Prize in 1945, a reception was arranged in his honor at Princeton's famous Institute for Advanced Study, where he had worked during World War II. Einstein gave an extempory speech there in which he referred to Pauli as his spiritual son and expressed the hope that Pauli would complete the work he had begun.

Max Born, a well-known German physicist, has also compared Pauli to Einstein in his book, *The Born-Einstein Letters*. When in 1954 a controversy appeared in the Born-Einstein correspondence, Pauli intervened in a conciliatory and clarifying way. Born mentions that Pauli in this connection remarked in passing that he had come in certain respects to the same conclusion as Born, but in a different fashion than Born, adding, "but it was just a detail". Born continues, "It is more than a detail. It shows that Pauli had long been familiar with all that I had to say. But this did not embarrass me. For ever since the time he had been my assistant in Göttingen I had been aware that he was a genius comparable only to Einstein himself. Indeed, from the point of view of pure science he was possibly even greater than Einstein even if as an entirely different type of person he never, in my opinion, attained Einstein's greatness".

Humanist

In certain respects, Pauli does not fit the picture people have of a representative of mathematical science: he was a mystic or at least had tendencies toward mysticism. Along with innumerable other Pauli stories circulated amongst physicists was that of the "Pauli Effect": if Pauli entered a laboratory the experiment that was going on then would always fail. Professor Fierz has commented to me that this is not to be considered merely a humorous story for people really believed it. For this reason Pauli's friend Otto Stern never permitted Pauli to visit his laboratory.

Along with physics, Pauli always had a vivid interest in history of ideas and in philosophy. The interest was awakened already during his school days when Ernst Mach recommended literature to him. Pauli studied in the humanities line at school and was therefore able to read Latin and Greek works in the original languages. When he was 13 years old he got from Mach a gift of an essay collection by Mach in which he demanded more lecture hours in schools for natural sciences, instead of classical languages. Young Pauli had written in this book a marginal note in which he presented a dissenting opinion claiming that one can get a vivid picture of the classical culture only if one is able to read classical authors in their original languages!

Pauli delved unusually deeply into history of ideas. The points of particular interest to him were those of different philosophers' concepts of space, time, and matter, as well as their conceptions of reality. With respect to each important term he performed a thorough-going investigation of the origin of it, then tracing the changes in the term's meaning through the ages.

Knowledge and Faith

Pauli delved with particular care into the scientific crisis which took place during the Renaissance, and in the 17th century. His view of the nature of this crisis and its repercussions give a new perspective on the cultural situation today.

Pauli's view was that people went too far in certain respects in the 17th century. This was particularly in regard to the strict application of mathematical laws to nature--the idea of absolute causality. This again plays a basic role in the formation of the concept of reality. The Copenhagen interpretation of quantum mechanics, the cornerstone of Pauli's philosophy, implies a new idea of causality and, a fortiori, of the nature of reality (see Appendix I).

Gradually the concept that nature could be governed by a mathematical system of laws became accepted during the Modern Ages, a concept on the basis of which one could, indeed, arrange and govern observations. Empirical science has simultaneously been a mathematical science, which has been able to describe the phenomena of nature exactly--while also taking advantage of them. In the course of time, natural scientists have completely accepted the concept that such description is always possible, to any degree of precision whatsoever. It is thus held that all phenomena can be explained on the basis of natural laws, if only they are investigated thoroughly enough. "Nothing happens without cause" is the general scientific view of today.

At the same time the worlds of matter and of spirit were sharply separated from one another, a development in which Cartesian philosophy played an essential role. Theology was forced to acknowledge a complete independence of empirical science in the realm of the material world. Theology itself concentrated its research on the spiritual world and on divine revelation. This separation between the worlds of spirit and of matter can be seen particularly clearly in the Protestant countries.

Pauli considered this sharp distinction between the spheres of faith and knowledge to be a great danger for Western culture. He emphasized in many different connections that the origins of religion and science are the same and that they cannot be separated from one another as has indeed

occured in Western countries in modern times. One result in particular of this view is the misconception that empirical science can answer all questions regarding reality.

Pauli was a great artist in mathematical technique who enjoyed solving the most difficult mathematical problems. Nevertheless, he saw clearly that the method of logical analysis was not the only way of comprehending reality. Another way is the conception of wholeness which intuition strives for. This is the way of arts, religion and mysticism. Pauli has never belittled the significance of this other way; indeed, it became more important than ever to him when he dug into the philosophical problems of atomic theory.

Quantum mechanics is bringing about a change in scientific thought, the importance of which can be compared to the crisis at the beginning of the Modern Ages. It is now also a question of finding an order in nature--the idea of causality. It was shown in the 17th century that nature, *i.e.*, the world which is perceptible to our senses, was governed by a mathematical order. Now it is becoming clear that the order was then held to be too absolute a thing. Irrationality also exists in nature, something which contemporary science and theology do not at all want to accept. Pauli considered this to be a very one-sided and unfounded position. It is time to acknowledge the existence of the irrational aspect of reality.

This has significance from the points of view of both science and religion. In a fresh examination of the basis of our concept of reality we find that knowledge and faith are not at all foreign to one another, but rather, are complementary, each completing the other in our comprehension of reality.

A New Conception of Reality

Problems associated with observations have demanded particular attention in atomic physics. No observational results can be obtained regarding atomic phenomena without at the same time interacting with the system which is being examined. An analysis of these problems led Pauli to a new conception of the relation between spirit and matter.

An observation always presupposes an interaction between the observer or his experimental equipment and the system under observation. Modern science has presupposed the view that the external material world has an objective reality, independent of whether or not that world is observed. The examiner, according to this view, is a "detached observer" who attempts to describe an objective reality on the basis of his observations.

Atomic physics teaches us that a picture of an objective world, independent of the observer's consciousness (psyche), is incorrect. The

observer is not "detached", rather, he is always at the same time a participator, influencing what takes place. The observer plans a certain test situation, carries out this plan, and interprets the results obtained. The type of outcome depends profoundly upon the contribution of the observer's psyche.

This is a new perspective for expanding our picture of the world, and it is changing our conception of reality. The worlds of spirit and of matter can no longer be isolated from one another, but rather, the "spirit" has an essential influence on the events of the "material world" also. Indeed, Pauli considered the question of the relationship between matter and spirit, the so-called "psycho- physical problem", to be the central one of our time.

Swiss psychiatrist C.G.Jung has powerfully influenced Pauli's thought--and vice versa. Jung's idea of synchronicity was developed further in his mutual exchange with Pauli. Admittedly, Pauli did not seem to really understand in the end what Jung meant by synchronicity. At any rate, the mutual influence proved important for both. A new concept of reality was sought, something which people had a vague feeling about, but which no one had grasped clearly yet.

The central outcome of atomic theory for Pauli was a new conception of causality. It can be called statistical (or probabilistic) causality. According to this new conception of causality, physical laws deal only with statistical mean values (expectation values), that is, with the average behaviour displayed when a sufficiently large statistical group is examined. The rational description of reality, *i.e.*, a description based on reason, is possible only in regard to statistical mean values. Something always appears in individual events which cannot be rationally described-- the so-called irrational aspect of reality.

Pauli's favorite philosopher, Schopenhauer, contended that the will is the fundamental stuff of reality. Reason cannot explain everything because the will is truly free and cannot therefore be bound by the restrictions of reason. I would hardly be interpreting Pauli's philosophy incorrectly if I said that a new creative aspect or fundamental stuff is associated with the conception of reality, a basic substance which can be preliminarily described as the will and which is independent of the world's rational order. Therefore, reason can never completely express reality, not even approach it asymptotically. Western science, which one-sidedly emphasizes the power of rationality in the material world, is based on too limited a conception of reality.

The Problem of Evil

In a letter to Fierz, Pauli stated that in the 17th century the question of the irrationality of reality was a pressing one because natural science directed its attention specifically on the material world. According to both Aristotle and Neoplatonism, matter was an irrational component of the world: something which could not be grasped by reason and thus could not be understood or governed rationally. When natural science directed its attention to matter, a powerful repression of the irrational occurred, however. The divine light penetrated the world of matter also, in the form of a mathematical order which was shown to govern material phenomena. In this way irrationality was completely shut off from the conception of reality.

This also influenced theology and the problem of evil. According to Neoplatonism matter was, indeed, evil--the complete lack of good. In the Modern Ages theology has repressed "the irrational", choosing instead to strongly emphasize only God's goodness and love and to speak less about the problem of evil.

We are now, according to Pauli, in a situation where irrationality and evil cannot be prevented from invading our range of vision. The repression of irrationality has given birth to a culture built on an unstable foundation. It is time to seek a new conception of reality, one which also embraces the irrationality of reality.

At the same time, there is a need to reconsider our image of God. God is not only a loving father--he also destroys. He declares:

*I form the light and create darkness,
I bring prosperity and create disaster;
I, the Lord, do all these things.*
(Isaiah 45:7)

We are now faced with this problem and should no longer remain silent about it.

In these fragments I have tried to piece together some kind of general view of the problems which we shall meet when we now begin a more systematic delving into Pauli's philosophical thought. The presentation in the following chapters is not tightly bound to Pauli's own text, for then it would be impossible to put together a homogeneous description. Nevertheless, enough citations have, hopefully, been included in the text to clearly show that the picture given of Pauli's thought is correct in all essential points. I would be grateful for any possible criticism in this regard, since understanding Pauli's thought correctly is, in my opinion, very important.

The Pauli-Fierz correspondence includes very original viewpoints on contemporary cultural dialogue. An aim of this introductory work is to focus attention on this correspondence, which is particularly interesting from the viewpoint of history of ideas.

BIOGRAPHICAL INFORMATION

Wolfgang Pauli was born in Vienna on April 25, 1900. His father, Wolfgang Josef Pauli, was a Jewish physician and later professor and director of a biological institute at the medical faculty of the University of Vienna. His mother, Berta Camilla Schütz, was the daughter of a Viennese writer. His father was converted to the Catholic faith, which was also his wife's religion. Wolfgang's sister, Hertha, was nine years younger than him. She later became a well-known novelist and biographer.

Wolfgang junior was baptized into the Roman Catholic Church, with the well-known representative of positivistic philosophy, Ernst Mach, serving as godfather.

Wolfgang attended secondary school in Vienna at the Döbling Gymnasium, where he graduated in the humanities line in 1918, the last year of World War I. During his school days he studied an unbelievable amount of mathematics and physics and in 1918 he also completed his first scientific research project in the field of relativity.

Pauli began his studies at the university in Munich in October 1918, where the degree of Doctor was conferred upon him in the summer of 1921. His most important teacher was Arnold Sommerfeld whose extraordinary mathematical skill and ability to apply mathematics to natural science had a powerful effect on Pauli.

When Einstein had to break his promise to write the section on relativity for the German "Encyclopädie der mathematischen Wissenschaften" in 1919, Sommerfeld asked Pauli to do it. The volume was published in 1921 and received very positive critiques. The same year Pauli completed his Ph.D. thesis in which he showed that Bohr's mechanical particle model of the atom gives incorrect results when applied to the ionized hydrogen molecule.

Pauli worked one semester in Göttingen under Max Born in the winter of 1921-22, but found Born's research style to be too formal for himself. In the spring he moved to Hamburg, to work as an assistant for Wilhelm Lenz.

Bohr met Pauli first in Göttingen along with his university colleague, Werner Heisenberg (one year younger than Pauli), when Bohr visited there in the summer of 1922. Bohr invited Pauli to come to Copenhagen for the academic year of 1922-23. In the beginning of 1924, Pauli

obtained a permanent position in Hamburg as an assistant professor ('Dozent'). The same year he came up with his exclusion principle.

Pauli visited Copenhagen quite frequently between 1924-27 and was also in close contact with Bohr and Heisenberg by letter. Heisenberg worked in Copenhagen in the winter of 1924-25, and again in 1926-27. These were particularly important years from the point of view of the development of atomic theory. Copenhagen was at that time the most important center of atomic research; the kernel of the "Copenhagen School" consisted of Bohr, Heisenberg and Pauli. They contributed the decisive ideas for quantum mechanics and its "Copenhagen interpretation", which became central to Pauli's philosophy.

In April of 1928, Pauli was appointed Professor of Theoretical Physics at the Technical University of Zurich (ETH). When, shortly afterwards, Gregor Wentzel obtained a professorship at the University of Zurich, the city became a particularly active research center for theoretical physics.

At this time, Pauli devoted himself in particular to the development of quantum field theory and is indeed one of its creators. Pauli was also interested in beta-decay, on the basis of which he came to his neutrino hypothesis. He had great confidence in the conservation of energy and impulse in each individual atomic process. This brought him to postulate the existence of a new particle in beta-decay processes, the neutrino, which was experimentally very difficult to detect. The neutrino's existence was not experimentally verified until 1956.

Pauli left the Roman Catholic Church in 1929. The following year he married, but the bond lasted only one year. After this followed a period of deep depression which he reached the bottom of in the winter of 1931-32. Pauli was a patient of Carl Gustav Jung at the time, and this acquaintance later resulted in scientific contact between the two. A state of emotional balance was finally reached through a new marriage with Franca Bertram on April 4, 1934.

When theoretical physicists of Jewish origin in particular ended up in difficulties in Germany for political reasons, Pauli helped many of them move abroad. After the "Anschluss" of Austria, Pauli himself, who possessed an Austrian passport, wound up in the danger zone, and when the war began he moved to the United States in the summer of 1940. He worked at Princeton's Institute for Advanced Study until 1946, but then returned to Zurich to serve as a professor at the ETH until his death.

Pauli was awarded the Nobel Prize in 1945 for his work on the exclusion principle.

Pauli died at the age of 58, after an illness of ten days, on December 15, 1958.

Pauli's interest in physics during World War II and thereafter lay particularly in the field of elementary particle theory. His best known achievements in this area concerned the relation between the spin of an elementary particle and its statistical behaviour (which Fierz was the first to point out), as well as the symmetry properties of elementary particles and the conservation laws associated with them.

A famous false assumption of Pauli's is related to conservation laws. T.D.Lee and C.N.Yang pointed out in 1956 that elementary particle parity (mirror symmetry) might be conserved only in strong interactions. Pauli, however, had an unshakeable faith in the conservation laws, including the conservation of parity, until experimental results showed in early 1957 that parity is not conserved in weak interactions.

In the course of time, Pauli had become a kind of superior judge for matters concerning theoretical physics, whose opinion was always desired regarding any disputed ideas. Pauli's sharp criticism kept research from going down the wrong track. He had to take a stand in regard to new ideas in all areas of physics. This responsibility as the "conscience of physics" demanded an extraordinary effort from him which cannot be seen in publications, at most only in his letters. It is said that Pauli himself has commented, "I have indeed mistakenly held something right to be wrong, but never considered something wrong to be right". This holds true.

Pauli's interest in philosophy and history of ideas was strong ever since his school days. In conversations with Niels Bohr regarding the epistemology of atomic theory and questions concerning the reality of the atomic world, these interests were strengthened. When the discussion on the interpretation of quantum theory revived after World War II, Pauli dug deeply into the history of ideas in order to form a well-supported view of the epistemological problems of quantum theory and of its ideological significance.

Pauli's epistemological publications appeared mainly in the fifties. However, they contain his philosophical ideas only in a very compressed form, nor are they completely understood. Pauli's large correspondence contains much more information regarding his thought. Pauli himself appeared to delay the publication of his philosophical ideas, as he was evidently aware of the criticism that was to be expected.

Pauli did not take part in politics. Already during World War I he displayed a strong aversion toward politics. He often noted in his letters that the will to power and the possibility to use knowledge as a tool for power are the dark side of natural science. Unlike his older friend Niels Bohr, Pauli restrained himself from all displays of opinion of a political nature.

The question of Pauli's relation to religion is a difficult one. He ended up with some kind of intellectually based faith which was free from all confessional bondages. He seemed to feel that religion would in the future be based upon science but by then he took it for granted that science would adapt the "quaternarian" philosophy (cf. Ch. IX) in place of its contemporary rational- materialistic attitude.



The forming of two different conceptions of reality begins: *Albert Einstein* and *Wolfgang Pauli* in Leiden in 1926.
(By permission of the Niels Bohr Archive)

Positivism and Realism

Wolfgang Pauli's godfather, Ernst Mach, was well-known both as a physicist and, in particular, as a representative of positivistic philosophy. What really is this positivism which for many is practically a word of abuse? It is significant that those who present evidence nowadays for the impossibility of positivism often bring up quite mutually contradictory arguments.

Physics has, without a doubt, had a powerful impact upon positivistic philosophy. It is also beyond dispute that this has had a considerable effect on the development of physics, since the creators of modern physics have presented clearly positivistic opinions during their most productive periods.

Positivism is a philosophy of the mathematical natural sciences. It has proven to be difficult, however, to define precisely what is meant by positivism. A powerful manifestation of this philosophy in the 20th century has been a philosophical school called logical positivism or logical empiricism. When the representatives of this school have undertaken to define exactly what they want to maintain, they have wound up making continual corrections to their theses. Let us therefore be content here with a very rough sketch of it.

At any rate, positivism involves a large dose of empiricism. Theories are not trusted unless they can be founded upon empirical facts. It has, however, proven to be difficult to define what is meant by "empirical verification" in detail. In any case, we can say that positivism in some sense involves the requirement of an empirical establishing of theories.

On the other hand, the demand of conceptual precision is emphasized in positivism. A theory must be so precisely formulated that its experimental implications are unambiguous. Only under such an assumption is it sufficiently clear how the experimental verification of the theory can be carried out.

These requirements have led positivists to an opposition towards metaphysics. They have sought to limit the scope of philosophy so that it would also be able to attain positive outcomes as in the natural sciences which have produced such brilliant and indisputable results in modern times. The aim is to cut off from philosophy overly general concepts and

"pseudo-problems" which are due to conceptual inaccuracies. In the positivist's opinion, it is not worth struggling over the basic question of existence, for that would result in the use of concepts which cannot be precisely defined, nor can assertions be presented in so unambiguous a form that it would be possible to agree on what follows from the assertion in regard to experience.

The concept of reality is one of those general concepts whose meaning is abstruse. For this reason, the positivist prefers to avoid using it and is satisfied if theories are verifiable, without requiring that they should describe any "reality". There is no need, therefore, to argue the point of whether atoms really exist when we only know the experimental predictions which follow from atomic theory and our experience confirms them. This attitude is known as instrumentalism, particularly in Anglo-Saxon countries: a theory is merely an instrument for governing empirical circumstances.

Many consider the concept of positivism nowadays to be so imprecise that they prefer not to use it at all but instead to speak of instrumentalism. It can thus be said that positivism has fallen into a pit of its own making: by restricting philosophy to operate only according to precise concepts it has made itself impossible by definition.

Actually, positivism has been increasingly abandoned after World War II and the concept of reality has continued to gain more respect. Everyone nowadays is trying to be a realist--*i.e.*, to understand reality. Problems have arisen, however, in regard to what exactly this reality refers to. One aim in particular of this book is to bring up problems which have appeared in atomic physics in this respect.

Quantum mechanics--the fundamental theory of atomic physics-- played a central role in the thought of Wolfgang Pauli. He took part in creating the "Copenhagen interpretation" of quantum mechanics and can, in fact, be considered the clearest representative of this interpretation. The younger generation of physicists has criticized the Copenhagen interpretation for its positivistic trend. In the next section we shall see that such a claim is not correct. In this regard a conceptual disorder prevails, the elucidation of which seems to have rather far-reaching implications.

Pauli's Positivism

Pauli's first scientific publications appeared in 1919. He made remarks in them concerning Hermann Weyl's new gravitational theory, which attempted to treat electromagnetic phenomena on the basis of general relativity. The characteristic feature of Pauli's thought lay in a remark concerning the concept of the field strength inside an electron. He noted

that such a concept is not permissible in a correct theory, as we have no way in which we could measure such a field strength; the electron is itself the smallest charged body which we can use as a test particle for the measurement of field strength.

This remark is typical of positivistic philosophy. All concepts which are not directly related to observation must be abolished from the theory. This criticism is actually the starting point for a critique directed towards the concepts of space and time, which Pauli continually presented in connection with microphysics: the use of the space-time continuum within a microparticle is called into question.

A more explicit criticism regarding these concepts of space and time was brought up in a letter which Pauli sent to Bohr on December 12, 1924. By then, the insufficiency of Bohr's atomic model was already apparent, and a new way to describe atomic phenomena and the atomic structure of matter was already being sought. The influence of positivistic philosophy can be seen clearly in the following remarks which Pauli made at the end of the letter†

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Die relativistische Dublettformel scheint mir nun zweifellos zu zeigen, dass nicht nur der dynamische Kraftbegriff, sondern auch der kinematische Bewegungsbegriff der klassischen Theorie tiefgehende Modifikationen wird erfahren müssen * (Deshalb habe ich auch die Bezeichnung "Bahn" in meiner Arbeit durchweg vermieden.) Da dieser Bewegungsbegriff auch dem Korrespondenzprinzip zu Grunde liegt, so müssen seiner Klärung vor allem die Anstrengungen der Theoretiker gelten. Ich glaube, dass Energie- und Impulswerte der stationären Zustände etwas viel realeres sind als "Bahnen".

Das (noch unerreichte) Ziel muss sein, diese und alle anderen physikalisch realen, beobachtbaren Eigenschaften der stationären Zustände aus den (ganzen) Quantenzahlen und quantentheoretischen Gesetzen zu deduzieren. Wir dürfen aber nicht die Atome in die Fesseln unserer Vorurteile schlagen wollen (zu denen nach meiner Meinung auch die Annahme der Existenz von Elektronenbahnen im Sinne der gewöhnlichen Kinematik gehört), sondern wir müssen umgekehrt unsere Begriffe der Erfahrung anpassen.

* Dies halte ich für sicher - trotz unseres guten Freundes Kramers und seiner bunten Bilderbücher. - "Und die Kinder, sie hören es gerne." Wenn auch das Verlangen dieser Kinder nach Anschaulichkeit teilweise ein berechtigtes und gesundes ist, so

The Numbers in the margin refer to the translations in Appendix IV (p. 192-228)

darf dieses Verlangen doch niemals in der Physik als Argument für die Beibehaltung gewisser Begriffssysteme gelten. Sind die Begriffssysteme einmal abgeklärt, so werden auch die neuen anschaulich sein.

So according to Pauli's view, when discussing the reality of the atomic world it is not possible to say that the electron is orbiting the nucleus, rather, we must try to form new concepts which relate directly to the "physically real, observable properties" of the atom, as was Pauli's very positivistic way to put it. This letter evidently got the wheels going in Heisenberg's head, for soon after leaving Copenhagen for his summer holiday he wrote his very first article about quantum mechanics on the island of Helgoland. In it he abandoned classical kinematics in describing the electron's motion, aiming instead only to predict the energy values of stationary states.

A new path for atomic theory began here which led to a completely unexpected control over the atomic world. It ended with a theory which predicted the "physically real, observable properties" of the atom but which was so abstract that its interpretation proved to be very problematic indeed. Logic guided researchers into the world, the basic nature of which appeared to remain incomprehensible. In this way the interpretational problems of atomic theory arose, problems which have been wrestled with for over half a century by now, the philosophical significance of them still creating very divergent opinions.

At any rate, the positivistic attempt to achieve a precise, mathematical theory which would yield unambiguous results in regard to observations, did produce fantastic results. Nor was that anything new in physics. The endeavours of physics have all along been positivistic during the Modern Ages.

The other fundamental theory of modern physics, the theory of relativity, was also created under positivistic stars. Einstein himself has related that Mach's philosophy gave him inspiration while he was developing his theory. The starting point of relativity theory is indeed a criticism of the concept of time, in which an attempt is made to define the simultaneity of two distant events in such a way that this simultaneity can actually be verified, using observational possibilities (signals) which we have at our disposal.

The positivism of the young Einstein guided him in creating the theory of relativity. In the same way, Pauli and Heisenberg were inspired in their work by positivistic criticism. Physics gives remarkable examples of the fact that positivistic philosophy is a sound philosophy and has led scientific thought in the right direction. But there are also dissenting examples.

Because of positivistic thought, Ernst Mach refused to believe in the reality of the atom, and this prevented him from following the development in an area in which physics has developed most during this century.

In the remarks cited above Pauli directed his criticism at the fundamental concepts of kinematics: the ideas of space and time. These concepts have grown obscure in quantum mechanics, so that it is no longer possible to describe in exact terms movements in the microscopic world. Pauli's view was that it will be necessary to go still further than modern quantum mechanics has in this respect. He noted in several letters that the space-time continuum was introduced into physics much too easily, for it presupposes that these concepts can be used in the same sense in microphysics also. Pauli stated that this way of thought originated with Newton's time, and felt we should now be trying to release ourselves from it. As an example, here is a fragment from Pauli's letter to Markus Fierz on March 30, 1947:

192 Ich erwarte immer mehr eine weitere Revolutionierung der Grundbegriffe in der Physik, wobei mir besonders die Weise, wie das Raum-Zeit-Kontinuum in ihr heute eingeführt ist, in zunehmendem Masse unbefriedigend erscheint. (Es ist natürlich genial, die Zeit nicht mehr zur Anordnung von Kausalreihen zu verwenden - wie einst im Mai - sondern als Tummelplatz von Wahrscheinlichkeiten. Wenn man aber statt "genial" sagt "dumm-dreist" ist es mindestens ebenso wahr. Es *geschieht* doch wirklich nur etwas bei einer *Beobachtung*, wobei auch - wie mich Bohr und Stern endgültig überzeugt haben - die Entropie notwendig zunimmt. *Zwischen* den Beobachtungen geschieht *gar nichts*, nur die *Zeit* ist auf den mathematischen Papieren "inzwischen" irreversibel weitergelaufen!)

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Such ideas gave Pauli a motivation for the research he was doing in history of ideas. Through it he was trying to explain to himself how the concepts of space and time developed through the ages. He was particularly interested in Newton's thought and how he arrived at his conception of an absolute space and an absolute time which were independent of matter. Pauli's interest in this was shared by Markus Fierz, who had dug deeply into the background of Newton's thought. On December 29, 1947, Pauli wrote to Fierz, saying:

193 Inzwischen habe ich meinen Ausflug ins 17. Jahrhundert weiter fortgesetzt. Dass Newton Raum u. Zeit quasi zur rechten Hand

Gottes gesetzt hat u.zwar auf den leer gewordenen Platz des von ihm von dort vertriebenen Gottessohnes, ist eine besondere Pikanterie der Geistesgeschichte, die mir erst durch Lektüre Ihres Newton-Vortrages bekannt geworden ist. Bekanntlich hat es dann einer ganz ausserordentlichen geistigen Anstrengung bedurft, um Raum u.Zeit aus diesem Olymp wieder herunterzuholen. Diese Arbeit wurde noch künstlich erschwert durch Kant's philosophischen Versuch, den Zugang zu diesem Olymp für die menschliche Vernunft zu sperren.

Deshalb ist für mich die Zeit besonders interessant, wo Raum u.Zeit *noch nicht* dort oben waren und zwar der Moment gerade *vor* dieser verhängnisvollen Operation. Daher mein Studium von Kepler.

PLC 0092.044

The concepts of space and time are central points of attention in the theory of relativity. For this reason the role of space and time in quantum theory is a matter which is of particular relevance in relativistic quantum theory. Crucial in this regard is quantum field theory, in which it is absolutely necessary to take into account the demands of both relativity and quantum theory. Pauli and Heisenberg formulated the basis for modern quantum field theory in 1929. Pauli has remarked in several connections, however, that quantum field theory is not satisfactory in its present form. He saw in it deep and fundamental problems which evidently specifically involve the concepts of space and time, but was unable to propose anything more suitable to replace the present theory.

Now that quantum field theory is the centre of so much attention, as a result of work on unified theories which are based on it, we ought to keep in mind that one of the creators of quantum field theory did not consider its foundation to be a final one; nevertheless, the development of the theory has continued upon it. It is also worth remembering that according to Pauli, "something occurs only during observation". This strongly positivistic remark may still prove to be important in the development of the theory.

Pauli's Realism

Pauli has stated that his philosophical attitude has essentially changed with time. Here he undoubtedly means that the positivistic aversion to metaphysics has died away. An interest in metaphysical things marked Pauli's latter days. He was not satisfied with the instrumentalist attitude either, but laid great stress on the search for a conception of reality in which

a picture of the microworld as atomic theory gives us would also fit. It was with this in mind that he began a thorough study of history of ideas and of philosophy, in order to find a solid foundation for his conception of reality.

The physicist's interest in philosophy is not normally so strong. The philosophical remarks which the most important developers of atomic theory made received sharp criticism from philosophers. Philosophical ideas presented by physicists were considered unsatisfactory. Bohr himself found that his philosophy of complementarity was misunderstood and did not raise the interest he had evidently expected. In particular, it was not considered justifiable to generalize the concept of complementarity and apply it to other fields of study. The Copenhagen interpretation also met with difficulties in the Soviet Union because it was considered to conflict with the philosophy of materialism.

Thus, physicists have become restrained in regard to philosophy. On the other hand, the Copenhagen interpretation has met with general approval among physicists, even though the interpretation seems to contain paradoxical features. It is possible, however, to avoid them if one holds the instrumentalist point of view, and is satisfied with the fact that quantum mechanics has proven to be an excellent physical theory. So physicists have become positivists and it is generally held that the Copenhagen interpretation of quantum mechanics necessarily presupposes a positivist (instrumentalist) philosophy. Pauli had a different view of the matter and an acquaintance with his philosophical ideas clarifies things, because it sheds light upon the most essential features of the Copenhagen interpretation. In this regard, Pauli is deeper and more elucidative than Bohr himself.

Pauli's fundamental philosophical attitude was that of a realist. In his opinion, the most important task of science is to explain the nature of the reality which science investigates. He wrote to Fierz on August 12, 1948:

193 Dieses Problem hängt sehr eng zusammen mit dem anderen Problem der *Idee der Wirklichkeit*. Der Laie meint gewöhnlich, wenn er "Wirklichkeit" sagt, spreche er von etwas Selbstverständlich-Bekanntem; während es mir gerade die wichtigste und überaus schwierige Aufgabe unserer Zeit zu sein scheint, daran zu arbeiten, eine neue Idee der Wirklichkeit auszubauen. Dies ist es auch, was ich meine, wenn ich immer betone, dass Wissenschaft und Religion etwas miteinander zu tun haben *müssen*. (Ich meine *nicht* "Religion innerhalb der Physik" und auch nicht "Physik innerhalb der Religion" - denn beides wäre ja "einseitig" - sondern Einordnung beider in ein Ganzes.) Was mir unter der neuen Wirklichkeitsidee vorschwebt,

möchte ich versuchsweise nennen: die *Idee der Wirklichkeit des Symbols*. Ein Symbol ist einerseits ein Produkt der Anstrengung des Menschen, andererseits ein Zeichen für eine objektive Ordnung im Kosmos, von der der Mensch nur ein Teil ist. Es hat etwas vom alten Gottesbegriff und auch etwas vom alten Dingbegriff. (Beispiel innerhalb der Physik: 'das Atom'. Die primären Qualitäten der Raumerfüllung sind ja verloren gegangen. Wäre es kein Symbol, wie könnte es "sowohl Welle als auch Teilchen" sein?) Das Symbol ist symmetrisch in Bezug auf 'Diesseits' und 'Jenseits', d.h. zweiseitig im Sinne der von Ihnen vorgeschlagenen Auffassung des Erkenntnisprozesses; es hat eine Beziehung zum 'Beobachten' und zum 'Begreifen', es kann mathematisch sein oder auch noch primitiver bildhaft. Das Symbol ist wie ein Gott, der auf den Menschen wirkt, der aber vom Menschen verlangt, dass er auf ihn (das Gottes-symbol) zurückwirken soll. Es scheint mir, dass nur so auch das Diesseits einen Sinn erhält und gerade das ist es, was mir bei Schopenhauer zu fehlen scheint. (Bei ihm: "Pessimismus" als Gegenposition zu den "positiven Superlativen").

PLC 0092.052

Here we are approaching the central areas of Pauli's philosophical thought. On one hand, the matter involves forming a conception of reality on a scientific basis, on the other a God-image. According to Pauli, these have a close mutual connection and for that reason "science and religion must always have something to do with one another".

The "positive superlatives" mentioned in the end of the quotation refer to the properties of God which are a part of the traditional image of Him: "omniscient", "almighty", etc. Pauli could not accept these kinds of attributes because they lead to contradictions. This does not, however, mean denying God. Pauli noted that a denial of God always appears to lead to somekind of surrogate for an image of God, as in Schopenhauer's will, Nietzsche's will to power, Freud's superego, Marx's matter and dialectics, etc. Pauli stated that modern man's God-image does not seem to contain any kind of consciousness; Schopenhauer's 'will', for example, is completely irrational and illogical.

At the heart of the above-quoted passage lies the question of the relation between the inner world of the subject and the reality he is searching for. With the aid of symbols we attempt to describe reality in such a way that the symbols also relate to our perception--our world of immediate observations. Pauli wants to say that this is the best way, in quite general terms, which we have of describing reality. Even mathematical concepts

and theories of physics are a symbolic way to describe reality--nothing beyond that. The interpretation of formalism is always a sensitive matter involving difficulties, nor can it ever be logically complete. In the end, an interpretation of formalism is always based on an intuitive comprehension--just as we must intuitively understand what the artist is trying to express by his art.

The question already emerges here regarding how Pauli's conception of reality differs from that of many physicists and philosophers of younger generations. They have tried to rid the interpretation of quantum mechanics of the "unclarity" which they contend exists in it. Pauli's view is that these endeavours are made "in the wrong direction". An interpretation can never be crystal clear in a logical sense, without introducing Platonic limitations into the concept of reality; presupposing that reality is a "world of ideas" which can be attained through pure thought.

Pauli related how Bohr often emphasized that truth (Wahrheit) and clarity (Klarheit) are complementary to one another. If demands of logical clarity are considered to be of utmost importance in philosophy, then the conception of reality grows vague. "True philosophy begins with a paradox", taught Bohr.

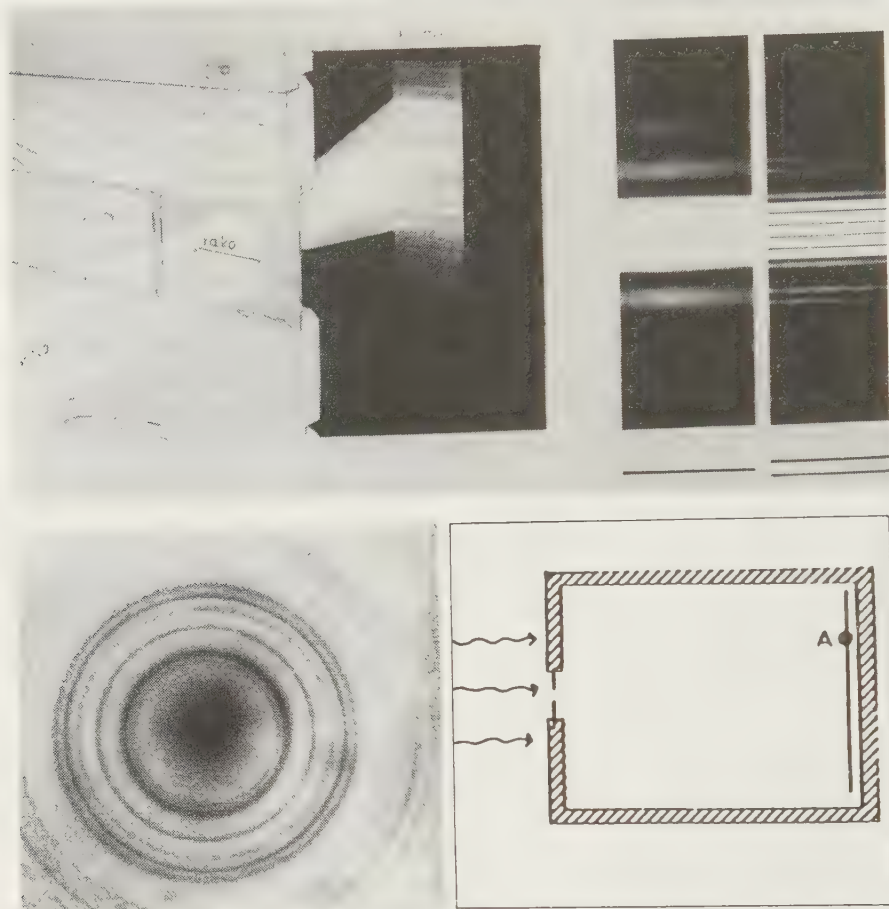
It seems that this is essentially a divide which determines the attitude with respect to the world view. The greatest part of the literature, which attempts to reach a clear interpretation of quantum mechanics, stems from an effort which, according to this view, is incorrect. It is assumed, after the manner of Descartes and Plato, that reality is something to attain through logical thought. In this way something essential is excluded, *a priori*, from the conception of reality.

The stuff of reality, which is in this way ignored, is something that cannot be reached through logical--*i.e.*, rational-- thought. Pauli referred to this fact as the irrationality of reality.

According to Schopenhauer, the basic constituents of reality are ideas (thoughts) and will. His main work was "Die Welt als Wille und Vorstellung" (The World as Will and Idea). Pauli's view is very close to that of Schopenhauer. He does not, however, agree with Schopenhauer's pessimism and rejection of religion, but he does emphasize that reality is essentially irrational--it cannot be grasped, in its entirety, through pure reason or rational analysis.

Pauli is thus a realist in the sense that he asserts that the central task of science is to shape a conception of reality. He was, however, guided by atomic research in a direction which the major part of Western science and philosophy has not yet been willing to go in. Irrationality is in general excluded from science and philosophy *a priori*. It would mean embarking on a "dangerous path". It is significant that Western theologians, too, have

adapted to the demands of Cartesian clarity to a great extent. Struggle over these questions is central to the interesting and extensive correspondence between Pauli and Fierz which is the main basis for this book.



Statistical Law

(Top) The diffraction of light in narrow slits. A sketch of the experimental arrangement on the left, photographs of diffraction patterns in the case of one and of two slits on the right.

(Bottom left) Diffraction pattern of a particle beam (cathode rays) demonstrating the wave nature of the beam.

(Bottom right) An individual event can only be predicted in a statistical sense which shows the indeterminism characteristic of the microworld.

The Reality of Opposites

Complementarity is a concept introduced by Bohr which seems impossible for many to accept. According to Bohr, description of the atomic world presupposes "complementarity": manners of description which complement one another. They are mutually exclusive, as in the case of a "particle description" versus a "wave description". In complementarity some people see the core of the "confusion" in the basic philosophy of atomic theory. In a way it really is the case, because it introduces the idea of contradictory elements in reality. But it is just this revolutionary idea which opens the way to a new perspective on science. Thus, the way the researcher responds to complementarity reveals his ideological attitude.

Pauli did not employ the concept of complementarity very much in his philosophical endeavors. He preferred to speak about statistical laws when describing the peculiarities of the atomic world. The same fundamental characteristics can be pictured in different ways, and without a doubt Pauli's manner has heuristic advantages. Pauli understood the idea of complementarity itself particularly well--he was perhaps the person who best understood Bohr's thought in general.

It is without a doubt difficult to explain the idea of complementarity in any degree of detail to the layman. The wave-particle dualism was the point of departure, which is a characteristic of the atomic world and something impossible to understand from the point of view of classical physics. Particle showers are always waves also at the same time while, on the other hand, waves always have particles associated with them, quanta. Nevertheless, waves and particles possess mutually exclusive properties: the ideal particle is perfectly localizable, whereas the wave is always extended in space and time. The mathematically simplest wave (the so-called monochromatic sine-wave) is completely unlocalizable: it "fills all space and endures eternally," *i.e.*, it makes no distinction between different positions or moments in time.

Atomic phenomena cannot be completely described without speaking about objects which in certain connections are waves but in other connections particles. The same radiation beam appears as a wave in certain experiments and as a particle beam in other experimental situations.

Nature has been compared to the god Janus who had two faces: we see one or the other of the faces depending upon which direction we look from. In physical terms, the observational setting which we choose determines which of nature's characteristics we shall see.

So we must simply accept as an experimental fact that the atomic world has contradictory properties. This feature comes up in different connections in the formalism of quantum mechanics. It has been so constructed that these contradictory--or, in a more exact manner of expression, these mutually exclusive--properties (*e.g.*, a particle's position and velocity) are included in quantum mechanics in an impartial way.

It must be explained here to the reader who is not well-acquainted with the matter, how the complementarity of the atomic world appears in measurements. In atomic theory, there are complementary quantities A and B, which cannot be simultaneously measured with an unlimited accuracy. If some observational method gives a very precise value to quantity A, quantity B will definitely remain inaccurate.

A common example of complementary quantities deals with position and momentum. The more precisely one is able to determine the particle's position, the more indefinite is the knowledge of the particle's momentum and vice versa: if an observational method is employed which gives the momentum very accurately, then the particle's position will necessarily remain very indefinite. This fact illustrates the new situation which observation involves when the object of observation is a microphysical particle or particle system.

Let us consider, for example, the determination of a particle's position. We need some kind of radiation for this, which will give us information about the particle's location. The more exactly we want to determine its position, the shorter must be the wavelength λ of the radiation we are using. It must be kept in mind, however, that radiation always consists of quanta; the wavelength λ of the radiation is related to the quantum's momentum p according to the equation:

$$p=h/\lambda$$

where h represents the famous Planck's constant characteristic of quantum mechanics. The shorter the wavelength of radiation used (small λ), the larger the values obtained for momentum (large p). Thus, a radiation quantum changes the momentum of the particle powerfully, the exact amount of this "disturbance"

being in principle undeterminable. For this reason, the particle's momentum becomes more indefinite the more precisely one attempts to determine its position.

Precision, which can be attained in observations concerning the microworld, is determined by the value of Planck's constant. This is expressed in the famous *Uncertainty Principle of Heisenberg*. If A and B are two complementary quantities and the degrees of precision to which it is possible to determine them by using a given measuring method are ΔA and ΔB , then their product $\Delta A \Delta B$ is at least of the same order of magnitude as Planck's constant h . The complementarity of the quantities A and B is thus reflected in that we can never attain an unlimited accuracy for both of them with the same method of observation, but rather, the accuracies obtained (in ideal cases) are inversely proportional to one another. The limit of accuracy is expressed by the so-called *Uncertainty Relations*.

In the case that one is endeavouring to determine the "state" of an atomic system, in the sense of macrophysics, values of complementary quantities are always required. Because these cannot be simultaneously defined to a greater degree of accuracy than that allowed by the uncertainty relations, one can never precisely define a system's state. On these grounds it is understandable that one cannot apply the idea of absolute causality to microphysics: if the initial state can never be precisely determined then sharp predictions can never be made for the results of future measurements. In microphysics, therefore, we find only probabilistic laws.

For the person who believes that we can attain a perfect understanding of reality through reason, it is difficult to accept the idea that quantum mechanics uses mutually contradictory methods of description. A logician knows that anything can come out of a contradictory theory. A contradiction is a catastrophe from the point of view of a mathematical theory. As soon as a discrepancy is revealed in a theory, it is proven wrong and is discarded. Just so, quantum mechanics can be accepted--many people feel so, at any rate--only if it can be formulated so that the "discrepancies" which complementarity involves have been done away with.

For this reason, in addition to some physicists, many philosophers--from Popper on down--have sought a logically "correct" mode of presentation for quantum mechanics. Hidden variable theories were very popular during the 50's, but they have gradually lost their appeal. Other attempts to

replace or complement the Copenhagen interpretation include quantum logic and various methods of logical analysis of the foundations of quantum mechanics, the application of different concepts of probability to quantum mechanics, and new proposals for interpretation. All these attempts are endeavours to do away with the "paradoxes" which the Copenhagen interpretation of quantum mechanics is found to contain.

These endeavours which have often grown into extensive fields of research start from the idea that quantum mechanics, which has been shown to be an extremely good theory--specifically in the sense of instrumentalism--must be interpreted in such a way that it contains no "logical contradiction". It is thought that these seeming contradictions are due to obscure concepts which the Copenhagen interpretation contains. It is above all necessary to release ourselves from Bohr's cherished concept of complementarity or at least to define it in a new and logically acceptable manner so that there are no longer any "contradictions" to be seen on the horizon.

This is all based on the belief that reason itself can attain reality. It is at just this point that the creators of the Copenhagen interpretation--amongst whom I include Pauli in addition to Bohr and Heisenberg--hold a different view. Bohr's conception was that logical clarity and truth are complementary to one another: if, in a one-sided manner, an emphasis is laid on the demands of clarity, truth grows dim.

This contains the view that *logic cannot attain the whole of reality*. Pauli has emphasized this even more strongly than Bohr himself.

This is the divide which separates Pauli from the opinions generally accepted today. Western thought has inherited a firm trust from the researchers of the 17th century in the potentiality of a logical theory for the attainment of reality. This confidence in the capabilities of reason is so deeply implanted into Western culture that a variant way of thought is automatically assumed to be in complete error. Pauli grasped the fact that the demands of logic do not necessarily correspond to the nature of reality itself. Central to his thought was the *irrationality of reality*--the view that reason could not grasp the whole of reality. This is an important theme in the correspondence between Pauli and Fierz.

Seekers of Another Way

In Einstein's view, quantum mechanics could not be the final theory of atomic phenomena specifically because quantum mechanics does not appear to give answers to all meaningful questions. Because quantum mechanics results in probabilistic laws, its predictions are only average values, or expectation values. Questions concerning individual events remain

unanswered: only probabilities are attributed to individual events. For this reason, Einstein felt that quantum mechanics gives an incomplete description of reality. Therefore he continued to wait for some kind of development to take place in atomic physics towards a theory which would be more complete in its description of nature and at the same time replace the probabilistic laws with absolute ones.

deBroglie had similar ideas already in the 20's, but the representatives of the Copenhagen interpretation convinced him to give up his efforts. Schrödinger also made attempts along Einstein's lines, in the direction of a more realistic philosophy, but eventually yielded--though clearly not without hesitation--to a philosophy corresponding to the Copenhagen interpretation.

After World War II, a new generation of physicists became involved with quantum mechanics and resurrected the criticism toward the "paradoxical" qualities of the theory. The empirical tradition in England caused difficulties for resident physicists. This was already seen in the note of the editor of *Nature*, in regard to Bohr's first article dealing with the Copenhagen interpretation (1928):

It must be confessed that the new quantum mechanics is far from satisfying the requirements of the layman who seeks to clothe his conceptions in figurative language. Indeed, its originators probably hold that such symbolic representation is inherently impossible. It is earnestly to be hoped that this is not their last word on the subject, and that they may yet be successful in expressing the quantum postulate in picturesque form.

Because of this note Pauli, in a letter to Bohr dated the 16th of June, 1928, remarked that the editorial note was comical and that he read it in the following manner:

Wir englischen Physiker wären schrecklich froh, wenn die im folgenden Artikel vertretenen Ansichten in Zukunft sich als unzutreffend erweisen würden. Da aber Herr Bohr ein netter Mensch ist, wäre eine solche Freude nicht liebenswürdig, und da er ein berühmter Physiker ist und öfter Recht als Unrecht hat, bleibt uns nur eine geringe Chance für die Erfüllung unserer Hoffnungen.

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It became fashionable in the 50's to make attempts to supplement quantum mechanics in such a way that the idea of unambiguous mathematical laws governing phenomena would also apply to the atomic

world. Particularly worth mentioning are the hidden variables of the English physicist David Bohm. He was also able to convince deBroglie to return to his old ideas, and this inspired a number of other French researchers to make endeavours along the same lines. In addition, many physicists in Communist countries--where the Copenhagen interpretation had created ideological difficulties--became enthusiastic about hidden variable theories.

The quantum mechanical formalism was completed in these theories by introducing additional variables whose values could not be experimentally defined, but which formally restored the concept of absolute causality to the theory.

Pauli completely rejected these attempts from the very beginning. He said that they were efforts made "in the wrong direction". Instead of trying to rid atomic theory of the indeterminism--or freedom--implied by its probabilistic laws, which was the aim in the theories of hidden variables, Pauli was interested in the philosophical consequences which indeterminism opened the door to. Pauli also made very sharp criticisms of the other attempts to abolish "paradoxes" from quantum theory which began to appear in those days. He was concerned that attempts "in the wrong direction" may awaken the interest of the younger generation for ideological reasons. On Jan. 6, 1952, Pauli wrote to Fierz:

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Lieber Herr Fierz,

Vielen Dank für Ihren Brief. - Um zur Gegenwart überzugehen: Herr Destouches war (am 3.J.) auch bei mir und hat ähnliches erzählt wie Ihnen. Dass Katholiken und Kommunisten sich in Frankreich gegen die Komplementarität (was "Indeterminismus" einschliesst) geeinigt haben, wundert mich nicht. Beide sind nämlich psychologisch an eine *eschatologische Erwartung* gebunden, ob diese nun im Diesseits oder Jenseits liegt, ist relativ unwichtig. Das "eherne Muss" der Geschichte - möge sie nun mit dem Triumph des "Guten" am jüngsten Tag oder mit der endgültigen Etablierung des Weltkommunismus enden - darf natürlich nicht in Frage gestellt werden. "Wo käme man denn da hin, wenn man das "Kladderadatsch", das ist das Weltende (= Ende des Kapitalismus) einer blossen Wahrscheinlichkeitsbetrachtung unterwirft?" Ich bin sicher, dass das die Psychologie ist. (Es ist mir schon lange aufgefallen, dass die Zeitungen - besonders auch die anglosaxonischen - ganz irreführend über die Beziehung von Christentum u. Kommunismus berichten, indem sie Unterschiede statt die Analogien hervorheben. Da ist doch

auch auf die Analogie der früheren Behandlung der Anhänger der heliozentrischen Lehre durch die Kirche mit der Behandlung der auf die Mendelgesetze basierten Genetik u. ihrer Vertreter im heutigen Russland hinzuweisen. Es ist aber auch zu sagen, dass *B.Russell* in seiner Geschichte der Philosophie u. auch sonst, ebenso wie ich hier die *Analogie* Christentum - Kommunismus hervorhebt. Gott erhalte die aufsässigen Leute.)

Ich kann nun Destouches' Bericht noch ergänzen durch Erzählung über Herrn *D.Bohm* (zurzeit in Sao Paolo, Brasilien). [Es folgen einige sarkastische Bemerkungen.]

Was Herrn Bohm bei mir besonders reizt und ärgert, ist der Umstand, dass ich erkläre, kein Positivist zu sein. Denn er habe doch "bewiesen", dass nur "das positivistische Vorurteil" dem Akzeptieren seiner kausalistischen Lehre der verborgenen Parameter entgegentstehe.

PLC 0092.084

When Schrödinger returned to his old criticisms of the Copenhagen philosophy in the 40's, Pauli used very strong language in his letters concerning Schrödinger's "neurotic desire" to return to his antecedents. He told Fierz that when reading Schrödinger's article it reminded him of a few lines of Morgenstern:

*Weil--so schliesst er messerscharf--
Nicht sein kann, was nicht sein darf!*

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This refers in the end to the irrationality contained in reality.

Absolute Causality and Freedom

As already stated above, Pauli preferred to describe the new conception of causality characteristic of quantum mechanics with the aid of the concept of *statistical causality*. While Bohr considered complementarity to be the new formative idea for the understanding of the structure of reality, replacing the old conception of causality, Pauli preferred to speak of statistical laws. The Swiss journal *Dialectica* asked Pauli to act as editor for a special issue dedicated to complementarity, which appeared in 1948. Pauli wrote an editorial for this issue in which he expressed his views in the following manner:

Only the result of those particular further observations which do not change the state of the system can be predicted with certainty, while in the general case only statistical predictions can be made regarding the results of further observations. The general theoretical statements about a given "state" of a physical system therefore refer to a statistical ensemble of many systems equally prepared. I am inclined to consider this renouncement of the quantum mechanical description on the predictability by laws of the individual observation on a single atomic system in a given state as the fundamental new result of the point of view of complementarity. This renouncement is understandable as a necessary consequence of the influence, unknown in principle, of the measuring instruments on the observed system.

The idea of statistical causality means that one surrenders a concept of causality which has been characteristic of science ever since the beginning of the Modern Times, and comprehends the regularity governing phenomena in a new way. Individual events are not restricted to physical laws any more than in the sense of probability laws, whence the verification of the law always presupposes a sufficiently large ensemble: a group of similar events (an ensemble or a whole). In a letter to Fierz on Nov. 26, 1949 (0092.063; the date of 26.9.1949 mentioned in the collection is incorrect) Pauli calls this new concept of causality *statistical correspondence*:

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Um sodann das *positive* Prinzip, das den Gesetzen der Quantenmechanik zu Grunde liegt, zu benennen, kam mir Bohrs Ausdruck "Korrespondenz" zu Hilfe. (*Nach* Aufstellung der Wellenmechanik spricht er immer noch von einem "Korrespondenz-argument" - siehe *Naturw.* 21, 245-250, 1933 speziell den Passus S.246, 2. Spalte oben). Jenes statistische Verhalten der vielen gleichen Einzelsysteme, die keinerlei Kontakt miteinander haben ("fensterlose Monaden"), ohne doch andererseits kausal determiniert zu sein, ist ja in der Quantenmechanik als *letzte*, nicht weiter reduzierbare gesetzmässige Tatsache aufgefasst (etwa wie bei Galilei die gleichförmig beschleunigte Fallbewegung). In meinem in der Zeitschr. "Experientia" im Abdruck befindlichen Vortrag über Komplementarität habe ich daher versucht, den Ausdruck "Korrespondenz" etwas allgemeiner als Bohr als eben die positive Seite der quantenmech. Naturbeschreibung kennzeichnend zu

verwenden. Es ist ja diese *statistische Korrespondenz* welche zwischen Kontinuum (Wellenbild) und Diskontinuum (Teilchenbild) vermittelt. (Dies etwas allgemeiner als Vermittlung zwischen 'Quantentheorie' u. 'klassischer Theorie' bei Bohr). Dort habe ich nicht ausdrücklich erwähnt, dass mir beim Terminus "Korrespondenz" die geistige Abstammung von der 'correspondentia' des Mittelalters ('Entsprechungen') deutlich hindurchzuschimmern scheint. In beiden Fällen handelt es sich doch um eine die gewöhnliche Kausalität transcendierende Form der gesetzlichen Naturbeschreibung, die auf irgend eine Art von Analogie basiert ist. (Dies ist auch der Fall bei Leibnizens prästablierter Harmonie)

Die Einzelsysteme der Quantenmechanik sind "fensterlose Monaden" und doch findet sich stets der richtige Bruchteil, der wie berechnet reagiert (abgesehen natürlich von den vorgesehenen, statistischen Schwankungen).

Das tertium comparationis des quantenmechanischen Falles mit dem des synchron. Phänomens ist *das aufeinander abgestimmte Verhalten verschiedener* (deterministisch-kausal nicht verbundener) *Ereignisse*. (Hierauf beruht ja der Begriff 'physikalische Situation' in der Quantenmechanik, *nicht* auf einer direkten gegenseitigen Beeinflussung der betreffenden Objekte.)

Die quantenmechanische Situation ist natürlich nicht *nur* eine Degeneration der allgemeineren "Synchronizität" (dies als hier vorgeschlagene Arbeitshypothese verstanden) sondern *auch* eine "*rationale Verallgemeinerung*" der gewöhnlichen deterministischen Kausalität (Bohr). Wenn der Bruchteil 1 ist (statt zwischen 0 und 1), so ist das ja ein besonderer Grenzfall, als der ja die alte determ. Kausalität, von der Quantenmechanik aus betrachtet, erscheint. Ich habe keinen Zweifel, dass die quantenmechanische "statistische Korrespondenz" viel näher auf der Seite des alten Determinismus liegt als auf der Seite des Synchronizität-phänomens. Von letzterem aus betrachtet muss die Quantenmechanik als eine *sehr schwache* Verallgemeinerung der alten Kausalität erscheinen. Und doch scheint mir die Quantenmechanik auch jenen Wegweiser nach der anderen Richtung zu haben, wo von willkürlicher Reproduzierbarkeit keine Rede mehr sein kann. Die Quantenmechanik scheint mir eine Art *Mittelstellung* einzunehmen.

Dies ist meine momentane Ansicht, zu der mir die Überlegungen Ihres Briefes gar nicht schlecht zu passen

scheinen. Der *Erfolg* des 'reasonable belief' - und damit auch die Möglichkeit von Naturgesetzen - scheint mir *stets* auf einer archetypisch bedingten Koinzidenz unserer Erwartung (psychisch) mit einem äusseren Naturvorgang (physisch) zu beruhen. Für den unanschaulichen Anordner gibt es eben die Unterscheidung 'physisch - psychisch' *nicht*. Es kommt mir aber mehr und mehr so vor, als ob das "naturwissenschaftliche Denken" in dieser Hinsicht nur ein Spezialfall von allgemeineren Möglichkeiten wäre. Vielleicht kommen wir darauf noch zurück. (Es hängt mit der 'Vorbehandlung' zusammen)

PLC 0092.063

Pauli has explained in great detail here what he means by "statistical causality" or "statistical correspondence". It is the "*final*, irreducible fact of physical law", or a new fundamental concept concerning causality in nature. Reasons for it can no longer be given, but rather, it must be understood as a new conception of the nature of physical law itself.

This generalized conception of causality contains, on the one hand, a new kind of physical law, one which profoundly concerns *causality* regarding statistical mean values or expectation values, but on the other hand, implies a certain *freedom*: individual events can no longer be governed with the aid of any kind of law. Despite this freedom, statistical mean values correspond to theoretical predictions. One can say that the idea of statistical causality contains both chance and necessity. How this "freedom" or "chance" associated with individual events is interpreted is no longer only a matter for science alone.

In the latter part of the quotation, Pauli compared the statistical causality of quantum mechanics with the concept of synchronicity presented by C.G.Jung. Pauli felt that synchronicity meant "regularity" which is still further from an absolute causality than the statistical causality of quantum mechanics is. We shall return to this question when we discuss the psycho-physical problem. The synchronicity which belongs to the field of psychology seems, at any rate, to differ from that of statistical causality in that it in general deals with events which are not reproducible, whereas statistical causality presupposes that we examine similar systems prepared in a similar way; on the basis of this it is possible to reproduce the same situation whence the statistical mean values and also the scattering which appears in an experiment can be compared with theoretical predictions.

The phrase "the abstract orderer" (der unanschauliche Anordner) alludes to Pauli's conception of the nature of the psycho-physical problem, to which we shall return later.

Pauli considered the nature of statistical causality also in the third part of a long letter on Oct. 13, 1951:

Nun kommt die grosse Krise des Wirkungsquantums: man muss das Einmalige und den "Sinn" desselben opfern, um eine objektive u. rationale Beschreibung der Phänomene zu retten. Wenn zwei Beobachter dasselbe tun, ist es wirklich auch physikalisch nicht mehr dasselbe: nur die *statistischen Durchschnitte* bleiben im allgemeinen dieselben. *Das physikalisch Einmalige ist vom Beobachter nicht mehr abtrennbar* - und geht der Physik deshalb durch die Maschen ihres Netzes. Der Einzelfall ist *occasio* und nicht *causa*. Ich bin geneigt, in dieser "occasio" - die den Beobachter und die von ihm getroffene Wahl der Versuchsanordnung mit einschliesst - ein "revenue" (1) der im 17. Jahrhundert abgedrängten *anima mundi* (natürlich "in verwandelter Gestalt") zu erblicken. *La donna è mobile* - auch die *anima mundi* und die *occasio*.

Es ist hier etwas offen geblieben, was früher geschlossen schien und meine Hoffnung ist, dass durch diese Lücke neue *Begriffe* an Stelle des "Parallelismus" eindringen werden, die einheitlich *zugleich* physikalisch und psychologisch sein sollten. Möge eine "glücklichere Nachkommenschaft" dies erreichen.

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The "physical individual case" refers here to individual events which cannot be unambiguously described when using statistical laws. Pauli emphasized the irrationality and subjectivity of individual events more strongly than Bohr, as is illustrated in Appendix I concerning the Copenhagen philosophy. The last paragraph of the quotation points out that the scientific picture of the world remains open in the case of statistical causality. Pauli anticipated new possibilities for understanding the psycho-physical problem as a result of this. He considered Descartes' dualistic world view to be a very unfortunate idealization, which has led Western thought astray in the Modern Age.

According to Pauli, the irrationality of reality finds expression in the fact that individual events cannot be rationally described. Although Pauli had strong Platonic tendencies, he did not feel that reason alone was able to attain the whole of reality. He tended to think that the irrationality of individual events displayed something similar to the world spirit (*anima mundi*) of the Neoplatonist's world, governing changes in the world.

Pauli's strong emphasis on the irrationality of reality is essentially equivalent to Bohr's advocating of the idea of complementarity. Both express the fact that the events of the material world ("phenomenal world") are not governed by an absolute causality, but rather, by a causality which is fundamentally statistical in nature. Both Bohr and Pauli understood this

to be a question of a fundamental change in the general conception of causality which concerned not only the events of the atomic world, but of the whole of reality--all fields of human knowledge. Science has in the Modern Age distorted the image of reality, oversimplifying it and creating an illusion that reality itself can be attained through the aid of a logical system. Those who believe in such an illusion neither approve of Bohr's complementarity nor of the idea of the irrationality of reality.

Conjectura Cabbalistica.
 OR,
 A CONJECTURAL ESSAY
 OF
 Interpreting the mind of *Moses*, in the
 Three first Chapters of *Genesis*,
 according to a Threefold
 C A B B A L A:
 Viz. { *Literal*,
 { *Philosophical*,
 { *Mystical*, or, *Divinely Moral*.

By HENRY MORE, D.D.
 Fellow of *Christ's College* in *Cambridge*.

EXOD. 34.
*And when Aaron and all the people of Israel saw Moses, behold, the skin of
 his face shone, and they were afraid to come nigh him. 30.
 Wherefore Moses, while he spake unto them, put a veil on his face. 35.*
 MATTH. 10, 26. 27.
*There is nothing covered, that shall not be revealed; and hid, that shall not
 be known.
 What I tell you in darkness, speak you in light; and what you hear in the ear,
 that preach you on the house-tops.*

L O N D O N,
 Printed by *James Flesher*, for *William Morden* Book-seller in *Cambridge*,
 MDC LXII.

The title page of Henry More's book on the Jewish Cabbala.
 (By courtesy of the Helsinki University Library)

The Metaphysical Roots of Science

The Birth of a Mathematical Natural Science

Pauli's excursion into the history of ideas mentioned earlier did not come to an end with the 17th century. After going through the humanities line in a secondary school he was fluent in both Latin and Greek and this gave him the competence rare for a physicist for unraveling the development of the ideas and concepts of natural science. The history of the concepts of space, time and matter was his particular point of interest. Since he, on the other hand, knew the literature concerning relativity theory and quantum theory to a greater extent than perhaps anyone else, Pauli had truly exceptional qualifications for forming a dependable picture of the development and contemporary situation of natural science.

Pauli's point of real interest, however, was that time when physics reached the synthesis presented by Newton--in other words, "the period when space and time were not yet up there", that is, on the Olympus of Absoluteness. Pauli was disturbed by the "shirt of Nessos" formed by the space-time continuum of modern physics. A central theme of Pauli's "positivistic criticism" was the idea that further revolution was needed in microphysics regarding the concepts of space and time. This criticism centered in particular around quantum field theory which is the most sensitive part of relativistic quantum theory.

In his letter to Fierz dated October 13, 1951 (see also p. 34), Pauli dealt with the concepts of space and time in the theory of general relativity. Fierz had just noted in his letter that space is also absolute in general relativity because it is "independent of the physical reality which fills it". Pauli noted that the central idea of the general theory of relativity is that the geometric properties of the space-time world become dependent upon "physical reality". On the other hand, Pauli affirms that in Einstein's gravitational equations, which associate energy with the geometry of space-time, there exist solutions also for the case when no energy is present, in other words, space-time can also be empty. As a matter of fact, the fundamental structure of the space-time world appears in exactly that case in which "the world contains nothing", *i.e.*, space and time exist as

absolutes. The effect of energy on space-time is a relatively small "deformation". Thus, Fierz's comment that the space-time world in relativity theory is an absolute one, *i.e.*, independent of matter, is justified in certain regards.

After this Pauli continued his journey into the history of ideas to the age before Kepler and Galileo:

Ich komme nun von der Physik des 20. Jahrh. sogleich zurück auf Newton und sogar noch etwas weiter zurück: zur Naturphilosophie der italienischen Renaissance. Das hat sehr viel mit dem Ende Ihres Briefes zu tun, der von Newton handelt; es ist ganz sachgemäss, denn das Ende enthält latent den Anfang und das noch Ältere ist immer das Neue (mit welcher Formel ich immer gerne die Konservativen und die Umstürzler zugleich widerlege). Die Funktion der englischen Neuplatoniker bei Newton war offenbar, die Verbindung mit der Naturphilosophie der Renaissance herzustellen, denn damals war man sehr neuplatonisch (seit Ficino oder wahrscheinlich schon länger) und *damals hat sich auch der Raum gegenüber den Dingen vervollständigt (= materialisiert)*! Nach meiner Ansicht handelt es sich dabei um die Vorwegnahme einer Wendung der Naturwissenschaft durch die Philosophie: Man musste wegkommen von der peripatetischen Tradition, wonach die Dinge "einen Ort suchen", was mit der Vorstellung begründet war, *dass die Orte im Raum solche physikalische Qualitäten haben*. Diese These war in der Renaissance kontrovers geworden, von vielen beibehalten (sogar von dem sehr neuplatonischen Giordano Bruno - bei diesem die *Unendlichkeit* des Raumes ermöglicht ihm Pantheismus) aber von manchen verworfen. Von letzteren möchte ich hier auf Grund meines sehr lückenhaften historischen Wissens (möge es von Basel aus - gesegnet sei diese humanistische Polis - ergänzt werden!) Bernardino *Telesio* (1508-1588) und Francesco *Patrizzi* (1529-1597) erwähnen. Ersterer leugnete die physikalischen Qualitäten der Raumpunkte (wenn ich nicht irre, betonte er auch deren vollkommene Gleichwertigkeit, d.h. - modern ausgedrückt - die Homogenität des Raumes), letzterer verfocht die "absolute" Existenz des Raumes *jenseits der Dinge*. (Man sehe auch bei Campanella nach!) - Man kann nicht genug betonen, wie *sehr* die Probleme von Leibniz, Spinoza und Newton in der italienischen Renaissance aufgerollt waren!

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Zum Neuplatonismus der Renaissance (siehe Ficino) gehört aber auch wesentlich die *anima mundi*, die auch eine 'anima movens' war. Jeder Planet hatte eine Einzelseele, doch wie kamen diese miteinander in Beziehung: auch noch seelisch, durch die *anima mundi*, an der ja die Einzelseelen *Teil* haben. (NB. Ich sehe Herrn Fludd* vor mir, wie er bei dem Wort "Teil" sofort die Stirne runzelt - also sagen wir ihm zu liebe: "mit der die Einzelseelen, sofern sie dem lichten Prinzip angehören, identisch sind").

Im 17. Jahrh. jedoch kam die *anima mundi* aus der Mode, diese Idee *verblasste* (gerne würde ich wissen wie Ihr Epigone H. More u. sein Kreis sich dazu gestellt hat - was ist das noch für ein Neuplatonismus *ohne* die *anima mundi*?) Und eben durch die so entstandene Lücke drang Proportion, Geometrie, Mathematik in die Ideen über die Bewegung ein und drängte zur Empirie, zur Messung. Man sieht diesen Prozess deutlich nicht nur bei Kepler, sondern auch bei Galilei. Dieser *verwarf* nicht nur die aristotelisch- peripatetische Tradition sondern auch den *Neuplatonismus* einschl. *anima mundi* und ging auf die Pythagoräer *und auf Plato selbst* zurück ("das noch Ältere ist immer das Neue"!)

Mit diesem Fortschritt (analytische Geometrie - Newton'sche Mechanik) aber entrückte der Raum in den Olymp des Absoluten und die Beziehung von Seele u. Materie wurde ein besonderes Problem, das im Dämmerlicht des "Parallelismus" verschwand so wie die Venus in der Morgendämmerung verschwindet.

Nun scheinen wir aber zu beginnen, daraushier zu leiden, dass man im 17. Jahrhundert zu weit gegangen ist (vgl. meine Keplerarbeit) und von damals her kommen "revenues"¹⁾, die mich nachts, und zuweilen auch tags, verfolgen - so wie die Venus als Abendstern zurückkehrt²⁾. Wenn etwas unsichtbar wird, so bleibt es doch wirksam vorhanden und schon hat uns die allgemeine Rel.-theorie in ihrem durch die Dinge "gekräuselten" "Zeit-Raum" die von den Peripatetikern überlieferte Idee der physikalischen Qualität der Raumpunkte ("Orte") in der verwandelten Gestalt des gik-Feldes zurückgebracht (wenn sie auch nicht gleich den ganzen horror vacui zurückbringen konnte!)

* The polemics between Robert Flood (1574-1637) and Johannes Kepler (1571-1630) is described in Pauli's Kepler article and also repeatedly mentioned in Pauli's letters quoted in this book.

1) Skandinavisch: "Gengangere" (zugleich Titel des bekannten Stückes von Ibsen). Die Silbe *gen* ist derselbe Wortstamm wie das englische *again* (=wieder). D.h. natürlich, dass das englische Wort aus dem älteren dänischen (*igen*) abgeleitet ist.

2) Ich glaube, dass *jede* Vermehrung des Bewusstseins *so* vor sich geht, dass dabei auch etwas im Unbewussten verschwindet, was vorher bewusst war und was immer viel später wiederkehrt. Das will ich mit dem Bilde der Venus ausdrücken und auch mit dem Spruch "das noch Ältere ist immer das Neue".

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This quotation is particularly representative of the correspondence between Pauli and Fierz. The history of ideas is quite central to it, particularly that of the development of the concept of space, into the form which we know after Newton: it is an empty container in which objects can exist and move. This is so familiar an idea to us that we can hardly think in another way--"a shirt of Nessos which we are no longer able to take off". Pauli emphasized that this very concept of space can be a hindrance to the development of physics. What if a description of the microworld should not contain any talk about "occurrences in space and time"?

Marcus Fierz has described the birth of this conception of space in his article "Über den Ursprung und die Bedeutung der Lehre Isaacs Newtons vom absoluten Raum" (Isaac Newton's Doctrine Regarding Absolute Space: Its Origin and Significance; *Gesnerus*, Sauerländer, Aarau, 11 (1954), pp. 62-120).

It is worth emphasizing in particular the powerful influence Neoplatonism had on thought during the Italian Renaissance and later on in England during Newton's age. Newton ended up dealing with the Neoplatonist trend of thought in Cambridge through Henry More in particular (who was also mentioned by Pauli in his letter). In addition to Platonian philosophy, More was also affected by Near Eastern mysticism, particularly that of Jewish philosophy. Judaism includes the idea of God as the "place" ("makom") of events. This appears in many Old Testament verses and, for example, in the Book of Acts, chapter 17, verse 28: "*For in Him we live and move and have our being...*"

Thus space and, correspondingly, time became absolutes for Newton, even "divine" concepts which existed independent of matter, "before things". The Aristotelianism of the Middle Ages did not contain such ideas, but rather, the universe was a plenum (horror vacui!) and separate individual elements had their own spheres, which they sought according to

their natures. Only atomists supported the idea of the "void", which made the movements of atoms possible. It is significant that side by side with the general acceptance of the idea of absolute space a revival of atomist doctrine took place at the beginning of the Modern Ages.

According to Neoplatonism, the transcendental One--God--was the basis of existence; we are unable to gain knowledge of Him through our intellect. The One created, out of His "overwhelming fullness", the World of Ideas, the structure of which we can comprehend through our reason. It is a world in which logic reigns supreme. Geometry gives the best conception of the World of Ideas, which has a changeless--invariant--logical structure and in which plurality reduces to unity with the aid of logic. According to the philosophy of Eleatics, the *truly existing*--that which really is--is one and invariant. It was the daring idea of Parmenides which manifested a

According to Neoplatonism, the World of Ideas gave birth to a spiritual world out of its completeness, which is the basis for the phenomenal world perceptible to the senses. The spiritual world, in turn, generated matter, which is the ultimate outcome of the creation process. The creative power was completely exhausted in matter. In the World of Ideas, the logical forms are perfectly expressed, whereas matter lacks them altogether. Fundamental to the World of Ideas is the *idea of good*, which is the intellectual equivalent of the transcendental One: the World of Ideas is inherently good. Matter, instead, is characterized by a complete lack of good--*privatio boni*. For Christian thinkers this involved the idea that matter is evil, something one must be freed from.

Thus, the Neoplatonic world view had four levels, in such a way, however, that the highest level--the very foundation and basis of existence--was unattainable through reason, *i.e.*, transcendental --the One. We comprehend the highest level of reality in the form of the World of Ideas, which we cannot reach through our senses but only with the help of reason.

The phenomenal world which is revealed to us through our senses, has a spiritual and a material element. The spiritual element forms a unity, a world soul, which finds expression in all perceivable things. This *world soul*, the *anima mundi*, gives the phenomenal world its sense and meaning. All material beings have a private soul, but these private souls are all manifestations of the one world soul; they can be distinguished from one another only in that they are bound to matter. The world soul, the *anima mundi*, is responsible for all changes and strives to realize the unity of all things in the material world, so that each entity seeks the "form" which corresponds to its substance and which belongs to it. Therefore, the *anima mundi* is also responsible for all movement and can be termed the *anima movens*.

The concept of absolute space grew out of these Neoplatonic grounds, space being the common basis for the description of the motion of all perceptible things. Space was an expression of the anima mundi: it was "before all things". It was a representative of the One in the phenomenal world. "In Him we live and move and have our being."

At the same time, a renewed interest in the practice of mathematics took place. Geometry was a point of special interest and Euclid's "Elementa" was published in Latin translations with commentaries. Nor did this interest in mathematics remain any longer purely a matter for the writing desk; people began to apply it to the physical world. It is difficult to say what was the cause and what the effect, but at the same time that mathematical natural science achieved its first great victories, to which Pauli referred in his letter, the anima mundi "went out of fashion". Exact mathematical methods were in demand for the description of motion, in order to be able to govern it accurately. The anima mundi was no longer sufficient for the explanation of motion because precise, mathematical predictions were what was wanted.

Thus it was that a mathematical natural science sprang from the soil of Neoplatonism and there was no longer any room for the anima mundi. Perhaps this can be seen most clearly in the development of astronomy. Copernicus introduced a new approach which attempted to describe planetary motion in a simpler way by using a more invariant description than that of the old epicycle theory. He said himself that he was influenced by Neoplatonism and so came to think that the motion of the planets could not be as complicated as that which the Ptolemaic model of the universe presupposed. Already in the beginning of the 16th century, Copernicus concluded that the Sun and not the Earth was the center of the universe and developed such a theory over a period of 40 years; the idea truly led to a simplification of planetary calculations--particularly after later development.

Kepler became acquainted with the Copernican model of the universe already during his student days, when his teacher Mästlin taught him the method privately. He quickly developed a firm faith in this new system again influenced by Neoplatonism. The Sun had to be the center of the universe because the Sun upheld the world out of its "superabundance" with the aid of its radiation--just as the One upheld everything which exists through its "emanation" according to Neoplatonism. A heliocentric system was a question of faith to Kepler, as well as a source of inspiration for his work. He was also absolutely certain that the world was governed by exact mathematical laws, with the help of which it would be possible to describe motion as accurately as observations allowed. The Neoplatonic belief, which was in him inseparable from his Protestant religion, supported him in his struggles, the outcome of which was a set of unbelievably exact laws

of planetary motion. This was the first great achievement of mathematical natural science, the importance of which his contemporaries generally did not at all comprehend--not even Galileo.

Kepler was a mystic, whose publications contained the kind of struggle to which natural scientists of today, astonished, just shrug their shoulders. He searched for a *harmony in nature* after the manner of Pythagorus, and it was this mystic belief itself which made his long-lasting struggle possible. It was his hidden energy source. Just as important to him, however, was his confidence that the universe--specifically including the phenomenal world--was governed by a simple logical order. These two apparently contradictory basic efforts--the struggle for a mystical over-all perspective and an adaptation of empirical science's severe methods--were the distinguishing marks of Kepler's work. Here one can see the influence of Neoplatonism at its best.

The *anima mundi* was not a foreign concept to Kepler. It was nevertheless discarded when, step by step, the mathematical description of planetary motion began to succeed. Kepler never really understood the reason for this motion, but he was not content simply to associate it with the world soul, looking instead to the Sun for a cause, after the Neoplatonic manner of thought: to the rotational motion of the Sun. Kepler thought that the Sun's rotational motion was transmitted to the planets via magnetic forces and for this reason planets continued to orbit the sun. However, he never discovered any precise laws for the explanation of planetary movements on this basis, nor did a correct explanation appear until 50 years later, with Newton's gravitational theory.

A New Concept of Causality

In the end of the letter quoted earlier, a new concept of causality was described which obtained its final form in the 17th century. There is reason to examine rather thoroughly in just what regard the "17th century went too far", as this contention is very characteristic of Pauli's thought. Actually, everything which is presented in this book is a tale of "revenues" ("Ghosts") which haunted Pauli "at night and also sometimes by day" and which were associated with Pauli's view that the world soul, the *anima mundi*, is attempting to get back into a scientific picture of the world.

The matter is a very complex one, and in addition to the history of ideas Pauli became particularly interested in the problems of the human psyche. The central idea, however, was the concept of a causality which governed the universe. The development of science in this regard took a new turn at the beginning of the Modern Ages, and this was just the point where Pauli felt science had gone too far. His opinion was that science would have to

change its direction now--returning, in certain regards, to the ways of thought which reigned during the time of Galileo and Newton.

The world picture of the later Middle Ages was founded upon Aristotelian philosophy. Neoplatonism became important during the Renaissance but the general trend of thought was based on the Aristotelian or peripatetic tradition. According to this, the world was a closed, spherical whole, the outer boundary of which was the sphere of the fixed stars, or firmament. The fundamental constituents of the world were "form" and "matter" which were combined in different fashions. Form meant a logical structure which was attainable through reason, giving each object its own particular essence. Matter itself had no form; only in combination with form did it become a real thing. Matter in and of itself did not exist at all, it merely referred to the potentiality to combine with different forms, thereby producing different kinds of things.

The simplest forms of existence for matter included four elements: earth, water, air and fire. Each of these had its own sphere in the sublunar part of the universe. The earth's sphere was closest to the center of the universe, encircled by the sphere of water; outside of that was a sphere of air, and finally, a sphere of fire whose borders extended to the edge of the sublunar universe. The superlunar world consisted of a fifth element, ether, from which the elements of the sublunar world were formed through the separation of opposites. The "form" of an object also meant its material constitution, everything which formed the basis for an understanding of the thing's particular "essence". Everything existed for a specific *purpose* and the essence of a thing displayed its *raison d'être*. Objects strove to attain their natural locations in accordance with their essences. Objects which contained a lot of earth tended downward, those with a lot of air upward, toward the sphere of air, etc.

A natural philosophy built on this kind of foundation concentrated on elucidating the essence of objects and on this basis tried to understand changes in the phenomenal world, *e.g.*, movements. This description of nature is qualitative. In contradistinction to this, attempts at a *quantitative* description gained strength during the Renaissance. Confidence grew in the view that changes can be described with mathematical laws. A new kind of trust developed in the reliability of sensory observation: the empirical research method. Observation and mathematical precision have gone hand in hand in the field of natural science.

This kind of research method presupposes a *new conception of reality*. The World of Ideas of Platonism found expression in the phenomenal world also. The changes which took place were governed by invariant mathematical laws; the logical structure of the World of Ideas found its expression in the possibility for stating mathematical relations between

them. Pauli affirmed in one of his letters that the divine light of the World of Ideas descended upon the material world through Kepler's work, thereby illuminating the world by the new concept of causality; the result was to abolish all irrationality from nature, *i.e.*, everything which cannot be governed rationally, with the aid of reason.

It was just this new concept of causality which was the nucleus of the new scientific method. A solid confidence grew in logic being perfectly realized in the phenomenal world too. The idea of *absolute causality* became accepted: all changes could be perfectly expressed according to mathematical laws, once all the causes behind something were investigated. This concept of absolute causality parallels that of the idea of unshakeable destiny in the events of life. "Nach ewigen, ehernen, grossen Gesetzen müssen wir alle unseres Daseins Kreise vollenden", wrote Goethe.

The concept of absolute causality indirectly implies a denial of anything supernatural in the events of the material world. "Nothing happens without cause"--so the idea of causality is often expressed, something a natural scientist interprets so that all "causes" can, at least in principle, be discovered through scientific methods. If a conception of reality is built upon this foundation, no supernatural causes can be considered as real. At first, natural scientists did not hold such an uncompromising view of the matter, but when the position of science was gradually strengthened, the belief in the potential of science grew. This ended in a scientific religion--scientism--in which the conception of reality is limited only to matters which can be discovered through scientific methods. We will return to these questions in the chapter which deals with the limits of science.

The principle of absolute causality was realized in a very concrete form in Newtonian mechanics. If all the forces affecting a particle are known, as well as the initial conditions, then with the aid of the equations of motion of mechanics it is possible to precisely calculate how motion occurs. In classical mechanics, knowledge of the initial position and velocity define the initial state; here velocity is to be understood as a vector, so that it is also possible to know the direction of it. This idea can be generalized to describe many-particle systems: if all the forces are known which affect the system's particles, as well as the initial conditions, then one can describe the motion of all the particles by mathematics.

The idea that it is theoretically possible to determine the future in advance, so that the events could, at least in principle, be predicted mathematically to an unlimited degree of precision is called *determinism*. This idea appeared in theology as the doctrine of predestination. Classical mechanics is described completely deterministically: movements can in principle be described to any degree of precision if only it is possible to ascertain all the forces and initial conditions. Laplace expressed this idea in

the form of his famous demon: a supernatural intelligence who is able to know all the forces acting in the world as well as the states at one given moment of all particles in the world, including those of micro-particles, is able to see at once both the future and the past.

The idea of absolute causality is crystallized in lucid form by *Laplace's demon*. In it, attention is paid only to mechanical events, i.e., movements, but this idea can be generalized to describe all phenomena. There is reason to emphasize, however, that the idea contains an important restriction. The idea of determinism is correct only on the assumption that all laws concerning phenomena as well as the initial conditions are known precisely (or at least in principle can be known). The idea, however, became impossible in the context of quantum mechanics because initial conditions could not be determined to any degree of precision whatsoever--in opposition to which appeared Heisenberg's uncertainty relations.

It is not generally known that Newton's view of causality was not in accordance with the idea of absolute causality. Or rather, a hesitancy appeared in his conception, which eventually related to contradictions he had noticed to exist between the idea of absolute causality and religious concepts. Fierz has in particular presented the idea that it was the awareness of this contradiction which may have been an essential reason for the depression which Newton underwent sometime after the publication of the *Principia*. At that time it became clear to Newton that his main work would be used to support atheism and materialism.

Newton's view of causality became inseparably intertwined with his ideas of absolute space and time. These questions were central ones in the Pauli-Fierz correspondence in the beginning of the 50's. Fierz has described in his article, published in 1954, the background to the introduction of the idea of absolute space. He shows that Newton's vague remarks regarding an infinite, fine substance ("spiritus") which filled space could be understood better with regard to what the Neoplatonist Henry More wrote about space and the world soul. Newton left it up to "the reader's deliberation" to decide whether that infinitely fine substance was by nature material or spiritual. Newton also added an appendix entitled "General Scholium" to the second printing of the *Principia* in which he referred to space and time as expressions of God in the world. If this is regarded in light of what More has written about these matters, Newton's "background" begins to take a clearer form.

The matter at question is the transformation of the Neoplatonic world soul into a new conception of causality, at the heart of which is the idea of an absolute space and an absolute time. Newton seemed to feel that space is inherently spiritual and that through it God maintains laws which govern the world. For this reason, he sharply rejects the idea that material particles

would in and of themselves have the ability to attract one another, if there was only a complete vacuum between them. In his letter to *Richard Bentley* in 1692, Newton wrote:

It is inconceivable, that inanimate brute matter should, without the mediation of something else, which is not material, operate upon, and affect other matter without mutual contact; as it must do, if gravitation, in the sense of Epicurus, be essential and inherent in it. And this is one reason, why I desired you would not ascribe innate gravity to me. That gravity should be innate, inherent, and essential to matter, so that one body may act upon another, at a distance through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking, can ever fall into it. Gravity must be caused by an agent acting constantly according to certain laws; but whether this agent be material or immaterial, I have left to the consideration of my readers.

Newton's law of gravitation, however, was interpreted in such a way that material particles in and of themselves had the ability to attract one another. The fact that this is indeed what would happen and that the *Principia* would become a powerful weapon in the hands of atheists and materialists became clear to Newton during this period, at which very time he also entered his period of great depression.

Perhaps Newton's thoughts can be pictured by saying that space was God's representative in the material world. It contained something which Newton was unable to express in words, but which characterized God's intervention in material events. The real reason for gravitation, as well as the more general basis for the causal order of nature, was hidden within space. God maintained the order of things, the causality being in effect only to the extent and as long as God saw fit for it to be. "Supernatural" events, for which no natural causes could be found, could not be excluded. Fierz wrote in his article on Newton (p. 105):

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Wir sehen hier, dass Newton den Naturgesetzen keine zwingende Gewalt zuschreiben wollte. Sie sind empirisch gefunden und geben das wieder, was in der Regel geschieht. Sie haben auch keine ewige Geltung, wie auch Gott den Bau der Welt nicht verewigen will. Damit wird versucht, die Welt als eine beständig werdende, sich im Fluss der Zeit entwickelnde zu

sehen. Die Zeit wird damit zu einer Schöpfungsordnung, wie sie ja auch das Attribut der ewigen Dauer des Schöpfergottes ist.

Actually, this kind of concept of causality parallels statistical causality. The text of the *Principia* has been written in such a way, however, that it expresses the idea of absolute causality. It is no wonder that science has been guided in a direction which does not correspond to Newton's theological views. The addition of the "General Scholium" in the second printing of the *Principia* could not change the situation, and natural scientists have, in fact, completely forgotten about the existence of that appendix, as well as about the words of warning which Newton had presented in his letters. Even if some modern physicists are aware of these comments of Newton, they consider them simply to be expressions of the age, something to which a "more advanced" natural scientist at best merely shrugs his shoulders.

According to Pauli, it was in just this regard that the 17th century went too far. Actually, this happened only after Newton's time. Newton himself understood the matter's implications and was appalled when it became clear to him what he had done in his *Principia*. After that, no natural scientist hesitated or paid any heed to the dangers which Newton saw as implicit in the idea of absolute causality. Belief in the idea that God had created the world as perfect, in other words, able to be perfectly described mathematically, produced as an outcome a world picture in which God no longer had any place. Perhaps He could still be accepted as a Creator who once made the world and instituted its laws.

With the passage of time, the moment of creation, estimated on the basis of this world view, became more and more remote, so much so that the idea of creation itself began to grow dim. An expression of the concept of creation is also found in modern cosmological models--the "Big Bang". Thus certain writers have already proclaimed that the creator is surprisingly idle since he is not needed for anything after all. Confidence in the statement that "nothing happens without cause" has given birth to a new religion, scientism, which wants to label all previous religions as being "unscientific".

All in all, the question is: On what basis can we claim that "nothing happens without cause"?

Integræ Naturæ

speculum. Artisque imago.



The World Soul, *Anima Mundi*, as the representative of God in the world.
(From Robert Fludd's book *Utriusque Cosmi ... Historia*, 1617).
(By courtesy of the Helsinki University Library)

Spirit and Matter

The Twilight of Parallelism

During the Middle Ages, no sharp distinction was made between matter and spirit. The entire world was at bottom spirit. The movements of animals were considered to be expressions of their fundamentally spiritual nature. The motion of inorganic matter was also conceived in the same manner. The heavenly bodies, for example, all had their own soul and this fact was the basis for an explanation of the orbiting of the planets.

The spiritual aspect of nature was of particular importance in astrology and alchemy. A central research goal of these medieval sciences was to explain the effect of material events on man's spiritual life and destiny.

When empirical methods were introduced, a new concept of reality became necessary. The world soul was forgotten and into its place came the mathematical laws of nature, with the aid of which it was possible to describe the changes occurring in the world. A confidence in absolute causality governing changes gained strength and the concepts of absolute space and absolute time were needed for the mathematical formulation of this idea.

The outcome was a vision of the world as a great machine, in which all changes took place according to perfectly causal laws, in addition to which changes were thought to be fundamentally mechanical, *i.e.*, due to the movements of macroscopic bodies or atomic particles.

Determining the role of man in this kind of a world was a problem, for he was attributed with a free will and was responsible for his actions. For this reason, Descartes presented a new view of the relation between matter and spirit, a view which has dominated Western thought ever since.

Descartes has displayed in a clear fashion the epistemological situation in empirical science. The starting point of his philosophy is that of doubting, which nevertheless leads to the assurance "I think, therefore I am". "Cogito, ergo sum" is his famous basic thesis. The existence of the external world presents more of a problem, because everything which can be known about the outer world on the basis of experience is founded upon certain internal experiences which sensory stimuli create in one's soul.

This is a problem which the philosopher has, at any rate, to solve in some way if he accepts the idea that knowledge of the external world is based upon experiences which are mediated by our senses.

The second basic assertion of Descartes' philosophy was God. Descartes presented several arguments for the existence of God, by which term he meant an absolutely perfect being. Then he concluded that God, who is also perfect in goodness, would not deceive us by creating in us a concept of an external world which did not actually exist.

Descartes' world view was built upon three basic concepts: "I", "God", and "the world". "I" represented the soul, "the world" represented matter, something which included "I's" body. In addition, Descartes adopted a mechanistic worldview, which became generally accepted in the 17th century. Nor did he accept the concept of action-at-a-distance, but rather, only that of immediate interactions through push-and-pull movement in matter. For this he needed the ether hypothesis: ether transmitted interactions between bodies which were located far from one another. The motion of the material world was governed by absolute causality.

For religious as well as other reasons, it was necessary to think that the world of personalities--the spiritual world--was completely independent of this world machine. In this way Descartes came to the dualistic world view, which contained two substances which were completely different in nature: *spirit* and *matter*. Spirit was the "thinking substance" (*res cogitans*) and matter was the "extended substance" (*res extensa*). These two substances formed two totally different worlds, between which there was no interaction whatsoever.

Plato's philosophy, too, was characterized by an inherently dualistic basic perspective. The opposite of the *truly existent*, i.e., of the World of Ideas, was the *non-existent*, which had no logical structure at all. The sensible world was a projection of the "truly existent" into the "non-existent". The dualism of Plato's philosophy found its analogue in Descartes' dualism of spirit and matter, which has afterwards powerfully influenced both philosophy and theology. The universe was broken down into two different substances and this has, according to Pauli, influenced the development of Western culture in a very detrimental fashion.

The difficulties implied by the sharp distinction between matter and spirit appear in questions concerning the interaction between the spiritual and material worlds. From the point of view of every individual "I" this means, primarily, the relation between the body and the soul. This is a weak point in Cartesian philosophy. According to Descartes, this relation can be understood on the grounds that God has created the universe such that "the spiritual world" and "the world of matter" are like pictures of one another, although there is no particular interaction between the two.

Geulincx attempted to clarify the matter by speaking of two clocks which are synchronized, although they are independent of one another. On this basis, *Malebranche* developed a philosophy called occasionalism, according to which man's will was unable to influence any movements of the body; however, it opens a possibility (occasion) for God's influence. From a dualistic point of view, God is an essential element in our picture of the world--at least as a Creator who has established the given relation between the soul and the body during the event of creation.

Later on, the concept of the mind-body dualism was termed *parallelism* because the spiritual world and the material world were said to be "parallel". This idea became very unclear, however, after science shut God out of the world picture. Science focused its interest more and more intensely upon the material world. Psychic phenomena, too, were increasingly researched with the aid of their material expressions: by investigating changes in the brain and nerves and by examining behavioural phenomena for which we can employ the methods of natural science. And so it was--as Pauli wrote--that "the relation of mind and matter became a special problem which disappeared in the twilight of 'parallelism' as Venus disappears in the light of dawn."

Statistical Causality

The general nature of statistical causality has already been discussed. Pauli felt that his change in the concept of causality influences all areas of human knowledge, not only atomic theory. We thus have reason to hold that the basic structure of reality does not correspond to an idea of absolute causality, but rather, is better described with the aid of statistical causality. Questions concerning the relation between mind and matter must, then, also be examined from a new perspective.

Many consider it exaggerated to say that the paradigm questions of atomic theory have such far-reaching implications. It must be taken into account, however, that quantum mechanics is the foundational theory of modern physics and that the change in the concept of causality affects, in principle, physics as a whole. As a matter of fact, quantum mechanics is nowadays applicable to extremely diversified physical phenomena, particularly also in elucidating the macrophysical properties of matter. In regard to the concept of causality, on the other hand, physics has traditionally held a decisive position. It is difficult to conceive it possible for any other field to employ a more rigorous form of causality than that in physics. There is therefore reason to examine what the implications would be of contending that the structure of reality corresponds to the idea of statistical and not absolute causality.

Thus, the idea used in science of "nothing happens without cause" no longer applies to individual events. Only statistical mean values have rationally analyzable causes. Individual events always contain a given "indeterminism" or "freedom". A rational description of phenomena never concerns individual events; they can be presented only in terms of statistical (probabilistic) predictions, thereby leaving a part of the questions open regarding individual events. As Pauli stated in his afore-quoted letter to Fierz on October 13, 1951, "From the point of view of physics, one can no longer separate the individual case from the observer"--and for that reason "it goes through the meshes in the net of physics". "An individual event is *occasio* and *not causa*." It was precisely because of this "freedom" contained in the individual event, which can no longer be governed by rational means, that inclined Pauli to hold the view that the world soul, the *anima mundi*, was returning into the world picture.

The fact that individual events always contain indeterminism is a new characteristic feature of the picture of the world. In addition to "causes" which can be rationally analyzed, it becomes always necessary to add an "irrational influence", something which could be termed "chance"--participating in each individual event. If only rational influences are accepted, one can no longer contend that "nothing happens without cause".

One often hears the argument in this connection, that the calculus of probability and the statistical laws derived from them are "just as rational" as deterministic laws. Quantum mechanical formalism, for example, can of course be considered very rational indeed, but it must be remembered that *interpretation* of this formalism is necessarily statistical. And it is just this interpretation which implies that the individual events contain irrationality (indeterminism). This irrationality becomes evident whenever the theory is compared to the experimental outcomes of individual events.

The scientific world view is very often *defined* such that it accepts only rational matters. In this way, eyes are closed to the fact that individual events can no longer be described in detail. Pauli, instead, focused particular attention on the irrationality of individual events, implied by statistical causality. He felt that a *component of reality*--the *irrationality* of reality--appeared in it, which must be taken into consideration when causality is conceived as statistical. According to Pauli, this is an essential new characteristic of the picture of the world and he expected that a new light could appear in the "twilight of parallelism" once the freedom is taken into consideration which the gap in the description of this rational world means.

The situation is changed with respect to the relationship between spirit and matter, to the extent that the physical world can no longer be considered as closed machinery. It is *open* in so far as phenomena have

"irrational causes", *i.e.*, "causes" which cannot be described in the framework of a rational analysis. In this way supernatural things can also be a part of the universe!

Pauli was particularly interested in this point. His publications contained only rather short comments on such things. Important in this regard was a lecture which he gave in Mainz at an interdisciplinary conference in 1955 by the name of "Die Wissenschaft und das abendländische Denken" ("Science and Western Thought"). His letters contained much more, particularly his extensive correspondence with Markus Fierz. In it, Pauli presented very profound ideas which are worth focusing serious attention on.

Jung influenced Pauli's thought to a great extent in this regard. Matters related to the "supernatural" cannot be distinguished from the unconscious region of the psyche. The contact with Jung was quite stimulating in this regard. Jung's conception of reality was, in essential points, deeper than, for example, Freud's view of the "subconscious".

But what can statistical causality teach us in regard to psychological questions? In picturing such matters there is always the danger of introducing personal biases. I nevertheless hope that the following comments correspond in all essential points to Pauli's thought.

When we state that the physical world leaves room for "irrational influences", this does not mean that, for example, somekind of energy flow takes place between the physical world and some imaginary dimensions in the world, in other words, that one could observe a measurable increasing or vanishing of energy in the physical world. The conservation laws of physics hold as exactly as ever (and not only in a statistical sense). The nature of the changes is, however, such that they always contain different open possibilities, all of which are in agreement with the laws of physics. Thus, in every individual event there is room for *different choices*. The situation is just as if a "supernatural will" would be influencing the world which decides in each individual instance: "So be it".

This "supernatural will" plays a similar role to that of the *anima mundi* in Neoplatonic thought. It is just as if the universe were influenced by another element in addition to the rational one, which can be grasped by the methods of empirical science. This "supernatural will" is not at all bound by logic; actually, it appears to be completely free in individual cases, but in such a way that (an average) causality is, however, valid, *i.e.*, in the sense of statistical laws. Within the framework of such generalized causality it gives a *direction* to events, that is, it makes choices.

Schopenhauer's picture of the world contains two fundamentally different elements: will and thought or idea (in German: "Wille und Vorstellung"). This is very close to Pauli's way of thought. The new,

irrational element in reality can be called *will*: it makes choices in individual events. The rational element, which science has traditionally described can be referred to as *thought* or perhaps--after the Platonian manner--*idea*. A world built upon a foundation of statistical causality is thus composed of idea and will. Idea is therefore the world's rational element, will its irrational (and thus noncausal) element.

If we assume that statistical causality is characteristic of human knowledge in all its areas, and therefore describes the general structure of the world, we will find these two basic elements everywhere, even, it is worth noting, in non-organic events.

What, then are spirit and matter after all? What is the mind's relation to the body?--These questions must be contemplated on a new basis. A complete, Cartesian distinction between the two, which was based on the assumption that the physical world is governed by an absolute causality, can no longer be correct. Now it is possible to contend that the "world of the spirit" (the world of personalities) is not at all completely distinct from the "world of matter". Pauli wrote that for this reason we should search for a *unified description* of them both--or, employing a medieval term, of their *conjunction*.

In his letter to Fierz on October 26, 1954, Pauli wrote:

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1) *Gesucht*: ein "**Zwischenreich**" (zwischen Materie und Geist. Seelisch bzw. "neutral")

Es ist 100 % *zutreffend*, dass "mich die Raumvergottung ärgert, also emotional berührt. Also steht hinter der Sache - die Anima."

Die "Anima" vermittelt zwischen Materie und Geist, zwischen Innen und Aussen. Durch sie *weiss* ich, dass man den "überhimmlischen Ort" der Ideen und die *chthonische* Tiefe des Menschen nur *zugleich* erreichen kann. (Es ist wohl möglich, dass Plato das schon nicht mehr wusste. Heraklit wusste es wohl.)

Deshalb ist es mir ein wichtiger *Unterschied*, ob die Anima in den Raum wandert, wie bei *Patrizzi* und *Bruno*, oder *ganz* hinunter in die Materie wie bei den Alchemisten. Ersteres verstösst nämlich gegen die Symmetrie (bzw. Identität) von Innen - Aussen, der die Alchemisten mit ihrer psycho-physischen Einheitssprache näher waren.

Aber diese Ganzheit ist auch in der Materie; und zwar scheint mir für uns das *psycho-physische Problem* eine ähnliche Rolle zu spielen wie für die Alchemisten der chemische Prozess und für die Astronomen und Physiker des 17. Jahrhunderts die Himmelsräume. Denn nur im *Unbekannten* hält sich die "Anima" gerne auf.

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As one can see from this short quotation, Pauli likes the symbolic language (and the attitude) of alchemy. The fact that Newton considered space to be actually divine was, in Pauli's opinion, a very one-sided view having serious repercussions. Absolute space was thought to be "before matter", and if things were viewed from this perspective, "anima wanders into space", and we end up with a Platonic, objective conception of reality. The external world is thus exalted at the cost of the internal one. This is exactly what happened in 17th century Western culture. Pauli expressed the hope that we should be able to return to the attitude of the alchemists (in "a new form", of course) by creating a set of concepts and new expressions which at the same time describe both the physical, external world and the psychic, internal world.

Pauli did not present any solution for the problem regarding the relationship between mind and body--even less for the more general one regarding the relation between spirit and matter! He merely emphasized the importance of the psycho-physical problem and that a *conjunction* between matter and spirit must be sought. "May a 'more fortunate offspring' achieve this", he wrote to Fierz on October 13, 1951.

The Idea of a Detached Observer

It is natural, on the grounds of Cartesian dualism, to come to the conclusion that the observer's effect on his test results can always be eliminated. The primary object in science is the idea that one can assume the "external world" of matter to be totally independent of the "I"--that is, the observer. For this reason we can speak of a *detached observer* whose presence in no way affects the events of the physical world.

This kind of view is the one generally held in the natural sciences, and it has given powerful support to materialism which considers the spirit to be merely a by-product of the evolution of the universe. The official state philosophy in Communist countries is based upon this kind of view. On the other hand, it also has a firm standing in Anglo-Saxon countries and amongst scientists in general. If the spiritual world is considered to be autonomous at all, it very often is imagined to belong to its own sphere,

without any interaction whatsoever between it and the material world. Theology has found this position to be a kind of fortress into which it has withdrawn as the powerful empirical science invades ever newer territories.

The Copenhagen interpretation of quantum mechanics, however, opens up the possibility for an entirely new perspective. Niels Bohr often emphasized that in the great drama of the world we are not merely spectators, but also actors. The observer always influences the outcome which he obtains through empirical methods: he chooses the equipment which he will use, and the way in which it will be used; he also interprets the results. We must also keep in mind the "irrational agent" in every individual observation--according to the statistical concept of causality--as a characteristic of the empirical method itself, thereby introducing an indeterminism which cannot be eliminated.

According to the Copenhagen philosophy concerning the interpretation of quantum mechanics, every observation must be viewed as an *interaction* between the "observer" and the "external world". This idea *destroys the basis of the Cartesian distinction*. That interaction implies that the "observer" affects the events of the "external world" whenever he obtains information from them, and for this reason the idea of a "detached observer" is problematical. Heisenberg wrote in his book "Physics and Philosophy" (p.75):

If one follows the great difficulty which even eminent scientists like Einstein had in understanding and accepting the Copenhagen interpretation of quantum theory, one can trace the roots of this difficulty to the Cartesian partition. This partition has penetrated deeply into the human mind during the three centuries following Descartes and it will take a long time for it to be replaced by a really different attitude toward the problem of reality.

This was the original spirit of the Copenhagen interpretation. In later years, however, Bohr changed his way of describing the situation. Perhaps this is understandable in view of philosophers' severe criticism and because the Copenhagen interpretation was responsible for difficulties for physicists in the Soviet Union, which Academician *V. Fock* particularly stressed during his visit to Copenhagen in 1957. The criticism of the philosophers evidently resulted in Bohr trying to avoid "unnecessary difficulties".

In his article, "Quantum Physics and Philosophy. Causality and Complementarity" (1958), for example, Bohr wrote the following:

Summarizing, it may be stressed that, far from involving any arbitrary renunciation of the ideal of causality, the wider frame of

complementarity directly expresses our position as regards the account of fundamental properties of matter presupposed in classical physical description, but outside its scope.

Notwithstanding all difference in the typical situations to which the notions of relativity and complementarity apply, they present in epistemological respects far-reaching similarities. Indeed, in both cases we are concerned with the exploration of harmonies which cannot be comprehended in the pictorial conceptions adapted to the account of more limited fields of physical experience. Still, the decisive point is that in neither case does the appropriate widening of our conceptual framework imply any appeal to the observing subject, which would hinder unambiguous communication of experience. In relativistic argumentation, such objectivity is secured by due regard to the dependence of the phenomena on the reference frame of the observer, while in complementary description all subjectivity is avoided by proper attention to the circumstances required for the well-defined use of elementary physical concepts.

Earlier, Bohr used to say that causality was no longer valid in atomic physics. Now, however, he began to emphasize that quantum theory does not contain "any arbitrary abandonment of the idea of causality". He also wrote that this theory "does not imply any appeal to an observer". Due to such "small adjustments", Fock was able to state in the Soviet journal *Uspekhi fizicheskikh nauk* (vol. 66, 1958), that Bohr now accepted the idea that "causality remains completely valid" on the atomic level and that "only its form of presentation has changed". Fock also asserted that now Bohr even agreed that quantum theory describes an *objective* atomic world. Certain expressions which Bohr had earlier employed "should not be understood as any kind of expression of a subjective attitude on Bohr's part; without a doubt these inexact expressions result from mere carelessness and we can therefore discard them without further comment". Fock meant particularly expressions such as "our knowledge about something" and saying "we" very often when one should be speaking only about the "laboratory".

A difference in opinion between Bohr and Pauli concerning the "detached observer" arose already in 1955. Bohr gave a lecture for the 200th anniversary of Columbia University in New York entitled "The Unity of Knowledge" and in getting his article ready for publication, he sent the manuscript to Pauli for criticism, as he often did. It is worth quoting the part from Pauli's response which concerns this topic (the letter is dated February 15, 1955):

It is with great pleasure that I received your nice letter and above all, the text of your lecture on "Unity of Knowledge". The general outlook of it is of course the same as mine. Under your great influence it was indeed getting more and more difficult for me to find something on which I have a different opinion than you. To a certain extent I am therefore glad, that eventually I found something: the definition and the use of the expression "detached observer", which appears on page 10 above of your lecture and which reappears on page 13 in connection with biology. According to my own point of view the degree of this "detachment" is gradually lessened in our theoretical explanation of nature and I am expecting further steps in this direction.

1) As you will see in the reprint on my lecture on "Probability and Physics", which I have sent to you, it seems to me quite appropriate to call the conceptual description of nature in classical physics, which Einstein so emphatically wishes to retain, "the ideal of the detached observer". To put it drastically the observer has according to this ideal to disappear entirely in a discrete manner as hidden spectator, never as actor, nature being left alone in a predetermined course of events, independent of the way in which the phenomena are observed. "Like the moon has a definite position" Einstein said to me last winter, "whether or not we look at the moon, the same must also hold for the atomic objects, as there is no sharp distinction possible between these and macroscopic objects. Observation cannot *create* an element of reality like a position, there must be something contained in the complete description of physical reality which corresponds to the *possibility* of observing a position, already before the observation has been actually made." I hope, that I quoted Einstein correctly; it is always difficult to quote somebody out of memory with whom one does not agree. It is precisely this kind of postulate which I call the ideal of the detached observer.

In quantum mechanics, on the contrary, an observation *hic et nunc* changes in general the "state" of the observed system in a way not contained in the mathematically formulated *laws*, which only apply to the automatical time dependence of the state of a *closed* system. I think here on the passage to a new phenomenon by observation which is technically taken into account by the so-called "reduction of the wave packets". As it is allowed to consider the instruments of observation as a kind of prolongation of the sense organs of the observer, I consider the unpredictable change of the state by a single observation--in spite

of the objective character of the result of every observation and notwithstanding the statistical laws for the frequencies of repeated observation under equal conditions--to be *an abandonment of the idea of the isolation (detachment) of the observer from the course of physical events outside himself.*

To put it in non-technical common language one can compare the role of the observer in quantum theory with that of a person, who by its freely chosen experimental arrangements and recordings brings forth a considerable "trouble" in nature, without being able to influence its unpredictable outcome and results which afterwards can be objectively checked by everyone.

Probably you mean by "our position as detached observers" something entirely different than I do, as for me this new relation of the observer to the course of physical events is entirely *identical* with the fact, that our situation as regards objective description in "this field of experience" gave rise to the demand of a renewed revision of the foundation for "the unambiguous use of our elementary concepts", logically expressed by the notion of complementarity.

Part 2 of this letter deals with the use of the concept of "chance" in biology.

Pauli appears quite amazed because the new expressions used by Bohr are clearly in contradiction to those of the original "Copenhagen philosophy" and to Pauli's own view. Despite Pauli's criticism, the passage in question in the final version of Bohr's article (in German) reads as follows:

Der Begriff Komplementarität bedeutet in keiner Weise ein Verlassen unserer Stellung als aussenstehende Beobachter, er muss vielmehr als logischer Ausdruck für unsere Situation bezüglich objektiver Beschreibung in diesem Erfahrungsbereich angesehen werden. Die Erkenntnis, dass die Wechselwirkung zwischen den Messgeräten und den untersuchten physikalischen Systemen einen integrierenden Bestandteil der Quantenphänomene bildet, hat nicht nur eine unvermutete Begrenzung der mechanistischen Naturauffassung, welche den physikalischen Objekten selbst bestimmte Eigenschaften zuschreibt, enthüllt, sondern hat uns gezwungen, bei der Ordnung der Erfahrungen dem Beobachtungsproblem besondere Aufmerksamkeit zu widmen.

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Bohr evaded here the question of the epistemological significance of the interaction between the observer and the observed world, which Pauli, on the other hand, considered to be perhaps the most interesting feature of the quantum mechanical situation. It is a question of central importance in his correspondence with Fierz.

When he spoke of the return of the *anima mundi*, Pauli probably wanted to say that all phenomena--also including inorganic natural phenomena--have a "spiritual background" which traditional science pays no attention to, for reasons of principle. Parapsychological phenomena, for example, were not unfamiliar to Pauli--as is known, he had close contact with C.G.Jung. It is worth keeping this in mind when recalling that Pauli wrote that "the physical individual case can no longer be separated from the observer".

It must be stated, however, that the interaction which Pauli emphasized between the psyche and the external world is generally by its nature *intersubjective*: researchers are generally of the same opinion concerning whether or not an experimental arrangement serves its purpose and how the results must be interpreted. This does not mean, however, that the results obtained would yield an objective picture of a reality which is independent of the observer (*i.e.*, of his consciousness). A picture of the external world is always the result of an interaction between the "observer" (Descartes' "I") and the "world". In biological terms, the "observer" has certain genetic capacities which leave their mark on the kind of picture of the world he is able to form. The observer's psyche also introduces the incalculable agent into the interaction, which Jung calls the *collective unconscious*. It had a tremendous impact on Pauli's thought and is one of the essential points of difference between the philosophical attitudes of Pauli and Bohr. The fact that Pauli and Bohr held different views concerning the idea of the "detached observer" is a particularly important point in which this difference in attitude stands out.

In Conclusion

If causality is not absolute, but rather, the world order corresponds to the idea of a statistical causality, then the foundations of the Cartesian distinction between spirit and matter are shaken. The "physical world" becomes open to influences which cannot be described with the aid of traditional science. It is then possible--although it is not logically necessary--to contend that the universe has a component which cannot be described on the basis of causal analysis but which nevertheless influences the events of the physical world.

This means that causal laws do not define the path of natural phenomena other than in a statistical sense, and there are therefore in every individual event *possibilities for choices*. One can see the "irrational component" of the world here, which finds expression in the indeterminism of individual events (in the scattering around expectation values).

I interpret the remarks which Pauli made about the return of the *anima mundi* to science as somekind of *panpsychism*: *all changes include a spiritual component* which is expressed, typically, in choices not describable with the aid of rational analysis. This component can be referred to as *will* in the same sense in which Schopenhauer used this expression. As a matter of fact, Pauli often spoke about "My Schopenhauer".

The spiritual component therefore finds expression in all *changes* of the physical world including those in inorganic matter. This constituent is more clearly displayed in living organisms; in the higher forms of life, particularly in the case of man, one can speak about the will in the ordinary sense.

The concept of the spirit, however, cannot be only identified with the irrational component of the world. The most characteristic expression of the existence of spirit is without doubt the *rational order* of the world.

It is a mystic fact that rational (logical) theories are able to describe the structure and the changes of the universe. This was the starting point for Plato's concept of reality and it has been the very origin of idealism. Pauli had strong tendencies toward Platonic idealism, and certainly felt that "spirit" was first and foremost displayed in rationality. The picture of the world, which is based on a statistical causality, contains, however, an "irrational component" which can *also* be referred to as "spiritual".

For this reason, Schopenhauer's philosophy seems to describe very well the basic traits of spirituality: *will* and *idea* (thought). They are not characteristic merely of psychic phenomena, but rather, appear in a certain sense also in physical phenomena. They are expressed in the restricted causality and in the free choice within the framework of statistical laws, when the generalized concept of causality (the idea of statistical causality) is employed. According to Pauli, spirit and matter are complementary expressions of reality, in the same sense in which we speak of "particles" and "waves" as complementary expressions of the atomic world.

The basis for existence is to be sought, in Pauli's opinion, *beyond* the mind-body distinction. It can be described as a kind of cosmic order which forms a single foundation for both the "internal" and "external" worlds. "The ordering and regulating must be placed beyond the difference between the 'physical' and 'psychic'--just as Plato's 'ideas' have

something of the concepts and also something of the 'natural forces'." (Letter to Fierz; January 7, 1948).

Pauli understood this "ordering and regulating" as the common source for science and religion. With the aid of intuition we can come in contact with it in the depths of our psyche--but we can also do so by studying the logical order and changes in nature.



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22. Okt. 1949

Lieber Herr Herr,

Vielen Dank für Ihren Brief. Ich habe mir erlaubt,
den auf Leibniz bezüglichen Teil desselben an Veyl
weiterzuleiten. Es sollte doch möglich sein, ihn davon
zu überzeugen, daß Leibnizens "Principium identitatis
indiscreuibilium" (er hat es wohl speziell auf die "Substan-
zen" bezogen) nichts mit dem Ausschließungsprinzip zu
tun hat. (Am liebsten scheint es mir, gerade umgekehrt,
nicht und nicht ersichtlich, daß man es nicht in ausreichen-
der Weise a priori verstehen kann - wie ich schon in meinen
ursprünglichen Behandlung herausgehoben habe.) Falls es
für Sonderpunkte Ihres Leibniz-Aufsatzes an Veyl und
an K. Gödel aus "Interesse" in Princeton werden werden,
dann bin ich sehr neugierig, wie Veyl darauf reagieren wird.

Schwieriger ist der zweite Gegenstand Ihres Briefs, nämlich
die Idee von Jung über "Synchronizität" etc. Als ich ihn
Erste Juli bewerte (entweder habe ich ihn selbst gesehen, noch
ihm geschrieben), sah er speziell als wichtig hervor, daß er
"Kausalität" auf eine in Raum u. Zeit definierte, "konkrete"
oder "verständbare" Ursachen beschränken wolle (um so etwas wie
"magische" oder "synchrone" u. "asynchrone" Raum u. Zeit defini-
erte Ursachen nicht in den Kausalitäts-Begriff miteinbe-
ziehen). Es ist natürlich ein sehr entscheidender Punkt, denn
nur in diesem Sinne sind Schopenhauers "Zusammenhänge"
gleichzeitiger Ereignisse "akausal".

Mir selbst scheint bei den sogenannten "synchronistischen"
Phänomenen noch vermittelbar, daß dabei Faktoren
mitwirken (in sehr provisorischer Weise)

†

"Bewusstseinslage" und "archetypische Visionen" genannt), die einer Kontrolle so weit entziehen, daß eine ²⁰⁴abschließende Reproduzierbarkeit dieser Phänomene nicht vorhanden ist (dabei auch ihre Zusammenhang mit dem Schicksal, der Heilmannschaft, dem "Xpovos" und der Tyde).

Für den Naturforscher ist es daher sehr verführerisch diese Seite der Natur entweder als bloßen Überplanen zu verwerfen (kann man einmal das die 'Soylla'), oder aber sie als rationaler reproduzierbaren Gesetzmäßigkeiten zusammenzufassen (wie kann es ein Einzelfall, wie es im Holstein (wenn) der Naturwissenschaft einzuordnen (kann man sich das die 'Cleryholis'). Ich habe mich bei Keplers Bedeutung für die Biologie bereits geäußert, und nun habe ich den Verdacht, daß Jung - trotz seiner Versicherung des Gegenteils - mit einem Mikroskop wieder denselben Fehler macht. Voran Jung für mir ein wenig zu weit unten, oben (sprach mit ihm) Wert legte, war der Zustand, das es sich ja um eine Gesetzmäßigkeit der Mikroskopie Verdunkelungen handelt, die nicht mit den wirklichen Strukturen (porys) sondern mit jenen fiktiven Richtungen am Tierkreis

(Voyage) ^{auf einen fiktiven Nullpunkt bezogen} verknüpft sei. Inhaltlich widerspricht diese empirische Regel nämlich nicht einem "akausalen" ^{schonmal oder Schlußsatz} Zusammenhang dieser Phänomene. Ich gehe so, daß dies ein wesentlicher Unterschied von Keplers Handpunkt ist, würde aber auch einen solchen (von Jung postulierten) Zusammenhang kausal machen. Das wäre eine Eigenschaft der Zeitungsberichte der Geburt von Verkettungen (im Gegensatz zu Lebigen), die man im Grunde - unter der Eliminierung jener gemeinsamen definierten Richtungen am Tierkreis - auch nachher noch reproduzieren könnte. Das scheint mir aber in unser System von ^{Natur} Gesetzen nicht zu passen. Ich plane, daß die Vereinigung aller mikroskopischen Daten und mikroskopischen Faktoren der Versuchsbearbeitung einmündig (Kontroll-mechanismen). - ²⁰⁵Ich habe diesen am 31. Okt. 1949 in der Konferenz in der Naturwissenschaften am 31. Okt. 1949.

Example of Pauli's handwriting.

From the letter to Fierz of October 22, 1949 (PLC 0092.065), describing the limits of the scientific knowledge.

(With permission of M. Fierz)

The Limits of Knowledge

Uncertainty

The fundamental idea of atomic theory is that matter is not infinitely divisible, but rather, is built out of somekind of fundamental particles. The ancient Greek atomists called these fundamental pieces of matter atoms. Every atom was indivisible and completely filled, so that nothing else could fit into the space an atom occupied. There was empty space between the atoms which made atomic motions possible and distinguished atoms from one another. The world was thus built out of atoms which are eternal and separated by a void.

Nowadays, we do not refer to these fundamental constituents of matter as atoms, as this name has later been exclusively designated for particular particles which are not indivisible; we call these basic pieces *elementary particles*. They do not appear to be indivisible in the strictest sense because most elementary particles consist of even "smaller" particles--quarks. As far as we know, however, quarks do not exist as freely observable particles, but rather, they appear only as some sort of quark combinations which are then termed elementary particles.

The concept of an elementary particle may sound a bit peculiar since most of them are composed of even smaller particles which cannot, however, exist in a free state. This idea is not a new one, however: already with the atomists of antiquity atoms were described in principle in the same manner as the contemporary particle physicists describe elementary particles. Lucretius Carus, who depicted the world view of atomism in his famous poem, "De rerum natura" (On the Nature of Things), wrote about the fundamental constituents of matter (primordia) in the following way:

The first-beginnings, therefore, are of solid singleness,
made of these smallest parts closely packed and cohering together,
not compounded by the gathering of these parts,
but strong rather by their eternal singleness,
and from these nature allows nothing to be torn away
or diminished any longer,
but keeps them as seeds for things.

In Latin:

Sunt igitur solida primordia simplicitate
quae minimis stipata cohaerent partibus arte,
non ex illarum conventu conciliata
sed magis aeterna pollentia simplicitate
unde neque avelli quicquam neque diminui iam
concedit natura reservans semina rebus.

(De rerum natura, I:609-614.)

The fundamental constituents of matter, which are referred to in English as first-beginnings, are constituted of still tinier pieces which for simplicity's sake (simplicitate: "by their eternal singleness") are bound to those particles which are the everlasting seeds of all that exists. Thus, there is nothing new under the sun! The fundamental idea of quark theory was familiar already to the atomists of antiquity.

Nevertheless, something new has emerged, the dualistic nature of atomic particles, the wave-particle dualism. Experimental research on particles has revealed that the movements of micro-particles cannot be depicted in the same manner as those of larger particles. A special mechanics of the microworld, quantum mechanics, has been created which has proven to be a truly excellent tool in the investigation of the secrets of the atomic world. It originated with the concept that the fundamental particles of matter are not "particles" in the normal sense of the word, but simultaneously also "waves". To use Bohr's terminology, nature displays complementarity (see p.25).

In 1927 Heisenberg presented the limit for the degree of precision which can be achieved with respect to the parameters of "particles" of the microworld needed in standard mechanics. This limit is expressed in the *uncertainty relations*, which give the accuracy with which one can define complementary parameters in any given individual experiment (p.27).

Heisenberg's uncertainty relations can be derived by analyzing an ideal experimental situation, with the help of which it is possible to obtain information about complementary parameters. The limit of accuracy is due to the "wave" associated with a microphysical "particle". As a result, there is always interference between individual waves which creates an obscurity in the values of complementary parameters: the exact measurement of position, for example, makes the value for velocity "hazy", inexact. And in the same way, a precise measurement of velocity obscures information concerning the "particle's" position.

The uncertainty relations give an exact limit for how precisely one can define the "state" of a system of particles in the sense of classical physics.

This makes it necessary to redefine the concept of "state", such that this concept is defined only to the degree of precision possible in a micro-physical system. This is accomplished by interpreting the wave which is associated with the particle system as the state of the system. A deterministic method of calculation can be formally applied to a "state" defined in this way: an equation can be given, the so-called Schrödinger equation, with the help of which a state can be calculated at any moment whatsoever, if the state is known at some time. It is exactly on these grounds that it is sometimes argued that the concept of causality does not change in microphysics, it is just redefined.

However, an entirely new situation arises because the wave function, which is called the state (or state function) in quantum theory, is not a directly measurable parameter. The interpretation of the wave function is the core of the problem. Quantum mechanical formalism presupposes a probabilistic interpretation of the wave function. Knowing a state in this new sense does not mean that we can obtain exact values for complementary parameters. We obtain predictions for measurable parameters only to the degree of precision permitted by the uncertainty relations. We can predict positions and corresponding velocities only in the sense of giving probabilities. For this reason it is incorrect to claim that the concept of causality has not changed. A transfer has taken place from a strict or absolute causality to a statistical one, which permits only probabilistic predictions: predictions the precision of which is given by the uncertainty relations. Some philosophical consequences of this situation have already been mentioned earlier.

It has been suggested that the uncertainty relations refer only to the inaccuracy of observations and do not prevent using concepts in a more exact sense than is possible in observation. Einstein's opinion was of just this nature: he felt that quantum mechanics does not prevent us from believing (and expecting!) that it appears imperfect and that a new atomic theory could be developed in the future to describe parameters more completely and thus more accurately than is possible according to the uncertainty relations. The so-called hidden variables theories originated with this idea and were developed particularly during the 50's with great interest. Physicists have in general not paid any serious attention to such ideas. They have gotten used to the fact that there is an absolute limit to precision in nature and, therefore, that determinism no longer corresponds to the nature of events, but that they must be analyzed on the basis of statistical causality. This limitation on precision is the result of nature's dualistic (or more correctly: complementary) nature, nor is there reason to expect that this new characteristic of reality would disappear with further development of the theory.

This attitude can be termed positivistic, because one strives to build a theory only to the degree of accuracy that the precision of the observational facts will permit. Physicists are generally positivists in this regard. Only a small minority of physicists struggle with dualism in principle and consider this to be sufficient reason on ontological grounds to look for a new way, in which determinism could be rescued by describing nature in more exact terms than in quantum mechanics. Most physicists (including myself) feel that starting out with ontological assumptions (for example, those of materialism) is not, however, the way to develop physics. It must be acknowledged that Bohr's complementarity and Heisenberg's uncertainty relations express important characteristics of reality, which cannot be neglected in the further development of atomic theory. There is therefore reason to modify the concept of causality such that it corresponds to the actual precision of the observations. And thus we end up with the concept of statistical causality.

Pauli's Attitude

Pauli was forced to take a stand concerning the attempts at ridding quantum mechanics of the "paradoxes" introduced by the idea of complementarity, when the theories of hidden variables came into fashion amongst certain younger physicists during the 50's. His absolutely refuting attitude toward these attempts has already been discussed in Chapter III under the subtitle of "Seekers of Another Way". Pauli often wrote his opinions to Fierz in a very straightforward fashion as can be seen from his short comments concerning Bohm and Schrödinger (see p.31). He considered the developers of theories of hidden variables to be "fools" who attempted to turn the tide of development back towards the line of thought of classical physics, hoping that determinism and the idea of the "detached observer" could be returned to physics.

Statistical causality brings with it characteristics which are for many people difficult to accept due to ideological reasons. Limits to rational knowledge appear according to which the scientific world view remains open: it does not answer all the meaningful questions. It was right here that the "irrational component" of reality or "irrationality", as Pauli referred to it, could be seen.

This is a real stumbling block for many. Confidence in the idea that the methods of empirical science can solve every problem regarding reality--at least in principle--has become very common during the Modern Ages and is directly related to the basic ideology of society in the East as well as in the West.

Marxist-Leninist philosophy contains a repression of irrationality. On the other hand, in the interpretation of constitutional law in the United States, it is considered to be of great importance to draw a clear distinction between science and religion, in order that science would contain no idea of supernatural intervention; this is instead a matter peculiar to religion. In this way it is difficult to admit that there would be limits to the methods of science, for it would open a way in the scientific world picture to the "supernatural" and "mystic". Pauli, in fact, interpreted the situation in exactly this manner and for this reason understood well that the idea of the irrationality of reality would evoke very powerful forces of repression.

The idea that science can not grasp reality as a whole is of course conceivable in the sense that science has not yet been developed to the extent that certain matters could be described within its rational framework. The situation which quantum mechanics has brought up is essentially a more serious one. Certain limits to accuracy have been revealed in atomic physics, the surpassing of which does not appear possible, even in principle. Thus, statistical laws are not the result of our lack of knowledge at the present moment, but belong to the very structure of reality. The region of "irrationality" cannot be reduced through more exact research; rather, it appears that it will always remain present, regardless of how highly developed the scientific world picture becomes. "Rationality" and "irrationality" are complementary matters, which in principle are both contained in all of man's knowledge.

A new perspective has opened up on the basis of atomic physics which is just as difficult to accept in the East as in the West. Physicists avoid wrestling over this matter by choosing, instinctively, the philosophy of instrumentalism. On the other hand, analytical philosophy has developed from the perspective of positivism and it has strong support from many quarters. It declares the existence of "irrationality" to be unscientific. In this way the Copenhagen philosophy has been sharply opposed in that form in which it originally appeared. At the same time the idea that the scientific world view could remain open to the supernatural and mystic has also been strongly rejected.

Under this ideological pressure, Bohr also appears to have had tendencies towards some "minor specifications". As was previously stated, in his later years Bohr made minor changes in expression in epistemological articles compared to how he described the basic philosophy of quantum mechanics in the beginning. These alterations had the effect of clearly separating Bohr's concepts from Pauli's in certain central philosophical issues.

In his first article on the interpretation of quantum mechanics, which contained the famous Como lecture (September 1927, published in the

spring of 1928), Bohr mentions twice the "irrationality" which quantum mechanics involves. He also spoke later repeatedly concerning "what we know about a given system". This means a certain subjectivity, expressing the fact that the quantum mechanical way of describing a given atomic system always implicitly contains an observer who has obtained information from the system and completes his description on the basis of it. In the lecture "Die Physik und das Problem des Lebens" (Physics and the Problem of Life), given in 1949 and published in 1957, Bohr expressed the idea of the observer's implicit presence in the following manner:

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Im Vergleich zur Erweiterung der mechanistischen Beschreibungsweise, welche die Darstellung der Ganzheitszüge atomarer Phänomene verlangt hat, stellen uns die Integrität des Organismus und die Einheit der Persönlichkeit einer viel weitergehenden Verallgemeinerung des Rahmens widerspruchsfreier Anwendung unserer Mitteilungsmittel gegenüber. In diesem Zusammenhang soll betont werden, dass die bei unzweideutiger Beschreibung notwendige Unterscheidung zwischen Subjekt und Objekt dadurch beibehalten wird, dass wir bei jeglicher Mitteilung, die einen Hinweis auf uns selbst enthält, sozusagen ein neues Subjekt einführen, das nicht als Teil im Inhalt der Mitteilungen auftritt. Es bedarf kaum besonderer Hervorhebung, dass gerade diese Freiheit in der Wahl der Trennung zwischen Subjekt und Objekt Spielraum für die Vielfalt der Bewusstseinsphänomene und die reichen Möglichkeiten des menschlichen Lebens schafft.

Bohr makes here an attempt to describe the effects of quantum mechanics on biology and comments that a quantum mechanical description always contains a distinction between the object and the observer. (Here the measurement device is seen as a part of the "observer", as an extension of his senses. What is seen as belonging to the observational apparatus and what to the system to be investigated must in each case be clearly agreed upon. Afterwards, the description regards only the system considered as an object, namely, "our knowledge of that system", on the basis of those observational results which the experimental apparatus in use gives.) The system to be described must always be clearly distinguished from the "subject" (extended as in the above-mentioned sense). In an actual description, the subject is present only implicitly, to the extent that the question is "concerning our knowledge of the system under question". How this is to be reconciled with Bohr's article of 1958 (p. 61), in which he states that "the concept of complementarity does not in any way mean

that we are discarding our position as an external observer" is difficult to understand. We plan the apparatus and define the distinction between it and the system to be described, and afterwards we interpret "what we know about the system".

For these reasons, Pauli was not satisfied with Bohr's formulations of the 50's. Pauli felt that our knowledge of an atomic system is always subjective and leaves questions unanswered in principle. According to his viewpoint, rational knowledge is only "part of the truth". A part of reality remains unattainable by rational means. Heisenberg's uncertainty relations are one way of measuring "how much irrationality" always remains unachievable. What we are able to describe precisely depends upon us, for we can choose a method of observation which gives a very exact value to a given parameter. A complementary parameter, however, remains in this way "fuzzy", and so "irrationality" is always present in individual events.

The concept of the fundamental limits to man's knowledge is, as seen, closely related to the question of the "detached observer". This is the reason, as I see it, for why so many people are overzealous on behalf of "realism". They want to rescue the world picture, according to which the "outside world" is describable objectively, not dependent upon the human consciousness. The "Copenhagen philosophy" in its original form--a form which Pauli consistently held to--could not accept this kind of idea. What we know about the "outside world" always depends on what kind of observational skills we have and how we outline (interpret) the results of our observations; it also depends on our will: what we particularly focus our attention on.

For the sake of clarity, there is always reason to emphasize, however, that the scientific world view is nevertheless *intersubjective*, because scientists agree almost unanimously on how given observations are to be interpreted. Nevertheless, it is important to understand that the "scientific world view" never concerns a completely "objective reality", but only a picture of reality colored by the hopes and abilities of man.

Pauli's view concerning the limits of rational knowledge is strongly connected to Jungian psychology. The concept of the collective unconscious has powerfully influenced Pauli's thinking and this is where we see the difference between Bohr's and his thought. In his letter to Fierz on November 3, 1948 Pauli writes:

Ich möchte aber nochmals zurückkommen auf die Beziehung des in meinem Aufsatz ("Hintergrundphysik") vertretenen Standpunktes zum Artikel von Bohr im Planck-heft der Naturwissensch. (Nr. III von "Atomtheorie und Naturbeschreibung"). Die Frage dieser Relation wurde ja von Ihnen

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aufgeworfen. Inzwischen habe ich die in meinem letzten Brief zitierten Stellen dieses Bohr'schen Aufsatzes, die von Parallelen Physik-Psychologie handeln, nochmals mit C.A.Meier durchbesprochen. Das Wesentliche ist, *dass Bohr's Ausführungen ganz vom Standpunkt einer reinen Bewusstseinspsychologie aus geschrieben sind*. Deshalb versteht Bohr auch unter "Einheit der Persönlichkeit" und unter "Einheit des Bewusstseins" etwas ganz anderes als wir. Es scheint mir deshalb, dass Bohr's Analogieen soweit sie *Psychologisches* betreffen (siehe das Schema in meinem letzten Brief, das diesen Analogieen entspricht) eine willkürliche Konstruktion ohne tiefere Bedeutung sind. Bohr verwendet den Begriff des Unbewussten *nie*; dieser Begriff liegt ihm so fern, dass er seine Bedeutung niemals erfasst hat. Ich erinnere mich auch an diesbezügliche Gespräche. Er gab ohne weiteres zu, dass Träume als Informationsquellen benutzt werden können - das hätten ja schon alle alten Völker getan - aber er bestand darauf, dass auch Träume Bewusstseinsinhalte seien. (In diesem Punkt war seine Haltung ähnlich derjenigen die ich bei Chinesen gefunden habe.) Zusammenfassend betrachte ich also den Standpunkt meines Aufsatzes als wesentliche Modifikation und Ergänzung von Bohr's Analogieen betreffend Physik-Psychologie, wie sich ergibt durch *Akzeptieren des Begriffes des "Unbewussten"*, wie er von modernen Psychologien Jung'scher u. auch anderer Richtung verwendet wird.

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As far as I know, Pauli's essay on "Hintergrundsphysik" (background physics) has not been preserved, but it probably contained comments on the impact which the essentially unconscious element of the psyche has upon the researcher's work. Perhaps it is worthwhile to quote relevant paragraphs from Bohr's article, which were subject to Pauli's criticism. The article was written for a collection of papers entitled "Wirkungsquantum und Naturbeschreibung" (Quantum of Action and the Description of Nature), published in honor of Planck's 70th birthday.

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Vor allem wird aber dieses Gebiet, wie schon berührt, durch Reziprozitätsverhältnisse gekennzeichnet, die mit dem einheitlichen Charakter des Bewusstseins zusammenhängen und eine auffallende Ähnlichkeit zeigen mit den physikalischen Konsequenzen des Wirkungsquantums. Es handelt sich hier um allbekannte Eigentümlichkeiten des Gefühls- und Willenlebens, die sich gänzlich der Darstellung durch anschauliche Bilder

entziehen. Insbesondere findet der scheinbare Gegensatz zwischen dem kontinuierlichen Fortschreiten des assoziativen Denkens und der Bewahrung der Einheit der Persönlichkeit eine eindrucksvolle Analogie in dem Verhältnis der von dem Superpositionsprinzip beherrschten Wellenbeschreibung des Verhaltens materieller Teilchen zu deren unzerstörbarer Individualität. Die unvermeidbare Beeinflussung der atomaren Erscheinungen durch deren Beobachtung entspricht hier der wohlbekannten Änderung der Färbung des psychischen Geschehens, welche jede Lenkung der Aufmerksamkeit auf ihre verschiedenen Elemente begleitet.

Es sei hier noch erlaubt kurz auf die Beziehung hinzuweisen, die zwischen den Gesetzmässigkeiten auf psychischem Gebiet und dem Problem der Kausalität der physikalischen Erscheinungen besteht. In Betracht des Kontrastes zwischen dem Gefühl des freien Willens, das das Geistesleben beherrscht, und des scheinbar ununterbrochenen Ursachszusammenhanges der begleitenden physiologischen Prozesse ist es ja den Denkern nicht entgangen, dass es sich hier um ein unanschauliches Komplementaritätsverhältnis handeln kann. So ist öfters die Ansicht vertreten worden, dass eine wohl nicht ausführbare, aber doch denkbare, ins einzelne gehende Verfolgung der Gehirnprozesse eine Ursachskette entschleiern würde, die eine eindeutige Abbildung des gefühlsbetonten psychischen Geschehens darbieten würde. Ein solches Gedankenexperiment kommt aber jetzt in ein neues Licht, indem wir nach der Entdeckung des Wirkungsquantums gelernt haben, dass eine ins einzelne gehende kausale Verfolgung atomarer Prozesse nicht möglich ist, und dass jeder Versuch, eine Kenntnis solcher Prozesse zu erwerben, mit einem prinzipiell unkontrollierbaren Eingreifen in deren Verlauf begleitet sein wird. Nach der erwähnten Ansicht über das Verhältnis der Gehirnvorgänge und des psychischen Geschehens müssen wir also darauf gefasst sein, dass ein Versuch, erstere zu beobachten, eine wesentliche Änderung des begleitenden Willengefühls mit sich bringen würde. Obwohl es sich hier zunächst nur um mehr oder weniger zutreffende Analogien handeln kann, so wird man sich schwerlich von der Überzeugung freimachen können, dass wir in dem von der Quantentheorie entschleierten, unserer gewöhnlichen Anschauung unzugänglichen Tatbestand ein Mittel in die Hände bekommen haben zur Beleuchtung allgemeiner Fragestellungen menschlichen Denkens.

What Bohr was trying to describe here with the aid of the concept of complementarity, Pauli was able to express more clearly using the idea of statistical causality. The chain of events in the physical world is not without gaps, but instead contains an indeterminism ("choices") into which the influence of free will fits very well. This is a question, however, concerning an "irrational influence" which cannot be described with the aid of a strict causal chain. In addition, the unity of the personality contains the unconscious as an essential element. This is something which Bohr did not at all take into account, whereas the unity of personality means above all, for Pauli, the unconscious area of the psyche which the phenomena of the consciousness--knowing, feeling, and willing-- cannot alter in any essential way.

Rational knowledge lacks this dimension of the unconscious. Here lies the limit of man's knowledge. We can never describe the influence of the collective unconscious on our conscious knowledge through rational means. It has, however, a decisive effect upon the direction of our attempts, beginning with those instinctual processes the outcomes of which are our sensory perceptions. We arrange and interpret the sensory stimuli which we receive in a manner characteristic of the human psyche and, therefore, we see the world in the way a human being sees it. The conscious psyche is responsible for only a minor part of our spiritual life. For this reason our knowledge, which by its nature is specifically rational, can never contain everything which confronts our investigations. The roots of knowledge are in the irrational unconscious.

In the depths of our unconscious psyche we can get some idea of the presence of the "ordering and regulating" which is a common source of science and religion.

Archetypes

"Naturerklärung und Psyche", a joint work published by Jung and Pauli in 1952, approaches the unconscious from two different directions. Jung presented in it his perspective of the noncausal aspect of reality by introducing the concept of synchronicity. Pauli, on the other hand, delved into the background of scientific work and examined the influence of archetypes which particularly interested him, using Kepler's work as an example. Kepler was a particularly interesting case. He was a researcher strongly rooted in medieval mysticism, while at the same time clearly displaying the ideals of the new, mathematical natural science. He was also unusually open in telling about his work--how it was that many unsuccessful attempts at last led him to his renowned laws of planetary motion. Pauli gives the motivation behind his interest in Kepler's work in

the following quote (taken from a letter to Fierz on December 29, 1947):

Deshalb ist für mich die Zeit besonders interessant, wo Raum und Zeit *noch nicht* dort oben waren und zwar der Moment gerade *vor* dieser verhängnisvollen Operation. Daher mein Studium von Kepler. Ich habe C.A.Meier versprochen, im psychologischen Club einen Vortrag zu halten über "Den Einfluss archetypischer Vorstellungen auf die Bildung naturwissenschaftlicher Theorien bei Kepler". Kepler benutzt das Wort "Archetypen" und auch "archetypisch" in einer Weise, die genügend ähnlich ist dem Gebrauch, den Jung von diesen Begriffen macht, so dass es nicht notwendig ist, einen speziellen Unterschied zu betonen. (Sie benützen wohl auch beide dieselben antiken Quellen.) Sodann glaube ich einen vielleicht nicht uninteressanten Zusammenhang aus Keplers Schriften nachweisen zu können zwischen seinem sphärischen Trinitätssymbol, das sich durch fast alle seine Schriften hindurchzieht, und seinem leidenschaftlichen heliozentrischen Glauben (in dieser Hinsicht sind Keplers Ausführungen in dem Optik-buch "Paralipomena ad Vitellionem" besonders lehrreich).

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The effect of the unconscious psyche on scientific work is most clearly crystallized in the concept of the *archetype*. Pauli describes the contents and significance of this concept in the beginning of his Kepler article in the following fashion:

Jede Teilerkenntnis dieser Ordnung in der Natur führt zu einer Formulierung von Aussagen, welche einerseits die Welt der Phänomene betreffen, andererseits über diese hinausgehen, indem sie allgemeine logische Begriffe "idealisiert" verwenden. Der Vorgang des Verstehens der Natur sowie auch die Beglückung, die der Mensch beim Verstehen, d.h. beim Bewusstwerden einer neuen Erkenntnis empfindet, scheint demnach auf einer Entsprechung, einem Zur-Deckung-Kommen von präexistenten inneren Bildern der menschlichen Psyche mit äusseren Objekten und ihrem Verhalten zu beruhen. Diese Auffassung der Naturerkenntnis geht bekanntlich auf Plato zurück und wird, wie wir sehen werden, auch von Kepler in sehr klarer Weise vertreten. Dieser spricht in der Tat von Ideen, die im Geist Gottes präexistent sind, und die der Seele als dem Ebenbild Gottes mit-ein-erschaffen wurden. Diese Urbilder, welche die Seele mit Hilfe

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eines angeborenen Instinktes wahrnehmen könne, nennt Kepler *archetypisch*. Die Übereinstimmung mit den von C.G.Jung in die moderne Psychologie eingeführten, als "Instinkte des Vorstellens" funktionierenden "urtümlichen Bildern" oder *Archetypen* ist eine sehr weitgehende. Indem die moderne Psychologie den Nachweis erbringt, dass jedes Verstehen ein langwieriger Prozess ist, der lange vor der rationalen Formulierbarkeit des Bewusstseinsinhaltes durch Prozesse im Unbewussten eingeleitet wird, hat sie die Aufmerksamkeit wieder auf die vorbewusste, archaische Stufe der Erkenntnis gelenkt. Auf dieser Stufe sind an Stelle von klaren Begriffen Bilder mit starkem emotionalem Gehalt vorhanden, die nicht gedacht, sondern gleichsam malend geschaut werden. Insofern diese Bilder ein "Ausdruck für einen geahnten, aber noch unbekannten Sachverhalt" sind, können sie entsprechend der von C.G.Jung aufgestellten Definition des Symbols auch als symbolisch bezeichnet werden. Als *anordnende* Operatoren und Bildner in dieser Welt der symbolischen Bilder funktionieren die Archetypen eben als die gesuchte Brücke zwischen den Sinneswahrnehmungen und den Ideen und sind demnach auch eine notwendige Voraussetzung für die Entstehung einer naturwissenschaftlichen Theorie. Jedoch muss man sich davor hüten, dieses a priori der Erkenntnis ins Bewusstsein zu verlegen und auf bestimmte rational formulierbare Ideen zu beziehen.

According to the world view of the Neoplatonists, as well as to the thought of alchemists, these premonition-like ideas belonging to the unconscious are created by the world soul. Each individual soul was an expression of the world soul, a copy or image of it bound to matter which returned to its natural states after death. Certain "harmonies", as Kepler called them, were hiding in our souls just like some sort of dim memory which some external or internal impulse could bring to our consciousness--as if we had "awakened" to a comprehension of the truth. This kind of Platonic conception regarding knowledge is strongly emphasized by Kepler, but the Neoplatonic conception of the world soul clearly began to give way to the mathematical description of nature. Pauli wrote:

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Man sieht aber deutlich, dass die anima mundi in Keplers Ideen nur noch eine Art Relikt ist und in seinem Denken im Gegensatz zu den Individualeelen der einzelnen Himmelskörper eine untergeordnete Rolle spielt. Obwohl ein Einfluss von Paracelsus und seiner Schüler auf Keplers Ideen ganz unverkennbar ist, war

doch der Gegensatz zwischen Keplers naturwissenschaftlicher Betrachtungsweise und der magisch-symbolischen Betrachtungsweise der Alchemie so stark, dass der zu seiner Zeit berühmte Alchemist und Rosenkreuzer Fludd eine heftige Polemik gegen Keplers Hauptwerk, *Harmonices mundi*, verfasste. Im Abschnitt 6 wollen wir auf diese Polemik zurückkommen, in der zwei einander entgegengesetzte geistige Welten zusammengeprallt sind.

Kepler's view was that archetypes exist in our souls, in much the same sense as in the early Platonian philosophy. Or, as a devoted Christian, he saw the soul as being created in the image of God, on the basis of which we have the possibility to comprehend God's ideas. An archetype which was central to Kepler's thought was the idea of the Trinity. The sphere was its geometrical symbol, a perfect whole which was displayed both in the spherical form of the universe (the outer boundary being the sphere of fixed stars) as well as in the spherical form of all the heavenly bodies. The sphere's center point represented the Father, who is the source of all things, the surface stood for the Son and the space in between was the region of the Holy Spirit. The process of creation was symbolized by radii directed from the center point to the surface, expressing emanation--"radiation"--which gave birth to and maintained the visible world. Kepler felt that this symbol of the Trinity was expressed in all of nature, and this view of the sphere as an image of the Trinity assured Kepler that the Sun is at the center of the universe, a mainspring of radiation and life, and not the Earth. The Sun was God's "abode" in the visible world.

Just as Plato, Kepler adored geometry, in which he saw the fulfilment of God's thought. As a representative of empirical natural science, he believed that these ideas would also find expression in the visible world where the simple laws of geometry reign. With great zeal he sought harmonies of the world, trusting that these would also find precise expression in observation. This faith supported him in his years of struggle, sometimes in very difficult living conditions. The outcome was that of the first great achievements of mathematical natural science.

In his main work, *Harmonices mundi*, Chapter IV, Kepler wrote:

The perceptible harmonies have that in common with the archetypal harmonies that terms require their mutual comparison, *i.e.*, the activity (*energeia*) of the soul; in this comparison consists the essence of both.

In Latin:

Commune enim habent harmoniae sensiles cum archetypalibus,
quod terminos requirant eorumque comparationem, ipsius
animae energiam; in hac comparatione utrarumque essentia
consistit.

Here Kepler has presented the mystery contained in the possibility of empirical knowledge. The fact that our logical thought corresponds to observation is truly amazing and has powerfully influenced great thinkers throughout the ages. This is also a clear expression of the effect of archetypes which organize our concepts in the dimness of the unconscious.

Kepler's solid confidence in the possibility of rational thought to truly attain reality was unshakeable. He belonged to the Platonists, whose belief in the unlimited potential of rational thought has gradually become that of Western science as a whole. It was in this regard that Pauli did not agree with Kepler. Pauli also had Platonian tendencies, but atomic physics had taught him to be critical in regard to the possibilities of rational thought. The basic structure of nature was such that rational thought would never be able to perfectly describe reality. Pauli wrote, therefore, that in the polemics between the English physician and alchemist Robert Fludd and Kepler, which he described in his article on Kepler, he tended to be on Fludd's side, even though he felt a strong sense of empathy with Kepler's attitude. It will be necessary to return to this point later on.

Synchronicity

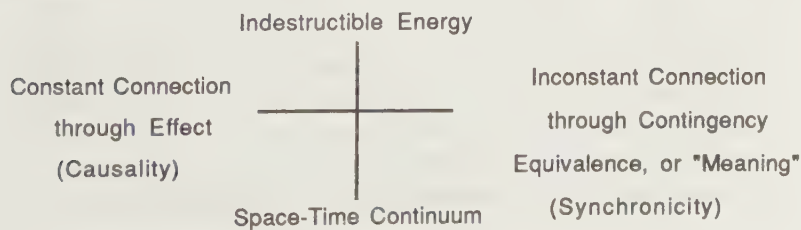
In his works, C.G.Jung has related many examples of instances in the course of his long life and in particular during his psychiatric practice, where it appeared impossible to explain that which happened with the aid of any kind of causal chain. These examples are, nevertheless, particularly influential psychic events, and it is difficult to deny that they belong to "reality"--i.e., are "real". They are examples which are often classified under the heading of parapsychology. Natural scientists easily dismiss them as being unusual coincidences. And because it is often out of the question to consider repeating them or that the same would take place again, he simply writes the matter off: the thing cannot be scientifically verified and so it doesn't interest him. This attitude results from the belief that all questions regarding reality, at least those which are worth paying attention to, are explainable through the aid of rational science and its empirical methods.

Jung thought differently about the matter. He felt that positivistic science, particularly including Freudian psychology, shuts out "unscientific" matters which may be very important indeed. He was interested, among other things, in mysticism and medieval thought, in particular alchemy and its symbolism. He was a deeply religious man, in his own critical and unbiased manner. He was, therefore, particularly interested in various forms of expression of the spiritual life which a positivist in general considers to be primitive and unsuitable for enlightened people.

Jung was of the opinion that there are dimensions to reality which cannot be attained through the methods of empirical science. In his old age he tried to find another method of scientific approach, along with causal analysis, and thereby get a hold on those phenomena considered to be "unscientific". And so in the book "Naturerklärung und Psyche", he presented another kind of regularity, along with causality, calling it synchronicity. Pauli was tremendously interested in this and evidently went to a lot of trouble to make it clear to himself what Jung really meant by synchronicity. We are restricted at this point to just quoting some of Pauli's thoughts regarding synchronicity.

What Jung refers to as synchronicity seems to include quite different coincidences experienced as mystical or "supernatural". In these cases, the occurrence of coincidences is characteristic and this has given rise to the name of this concept: a given psychic situation in which a particular archetype dominates occurs at the same time as some external event so that the coincidence is held to be very significant. This can be due to coincidence being considered to have a certain "meaning" behind it or that a surprising similarity is revealed which powerfully affects the psychic state. This type of situation is of the same kind as the harmony between an internal archetype and an external event, something which is a basic event in the rational understanding of the world, as just asserted-- somekind of intellectual "ahaa" experience. It is not a question, however, of some kind of revelation of a causal relation, but of a coincidence which, explicitly, is not causal in nature.

In his conversations with Pauli, Jung came up with the following type of diagram, by which he tried to sketch out the concept of synchronicity:



Here "indestructible energy" probably refers to the dynamic laws of conservation, *i.e.*, the conservation of energy and momentum.

Jung ended his article with the following remarks:

Synchronicity is no more baffling or mysterious than the discontinuities of physics. It is only the ingrained belief in the sovereign power of causality that creates intellectual difficulties and makes it appear unthinkable that causeless events exist or could ever occur. But if they do, then we must regard them as *creative acts*, as the continuous creation of a pattern that exists from all eternity, repeats itself sporadically, and is not derivable from any known antecedents. We must of course guard against thinking of every event whose cause is unknown as "causeless". This, as I have already stressed, is admissible only when a cause is not even thinkable. But thinkability is itself an idea that needs the most rigorous criticism. Had the atom corresponded to the original philosophical conception of it, its fissionability would be unthinkable. But once it proves to be a measurable quantity, its non-fissionability becomes unthinkable. Meaningful coincidences are thinkable as pure chance. But the more they multiply and the greater and more exact the correspondence is, the more their probability sinks and their unthinkability increases, until they can no longer be regarded as pure chance but, for lack of a causal explanation, have to be thought of as meaningful arrangements. As I have already said, however, their "inexplicability" is not due to the fact that the cause is unknown, but to the fact that a cause is not even thinkable in intellectual terms. This is necessarily the case when space and time lose their meaning or have become relative, for under those circumstances a causality which presupposes space and time for its continuance can no longer be said to exist and becomes altogether unthinkable.

Pauli had apparent difficulties in understanding the concept of synchronicity. This is seen, for example, in the quote on pp.32-33 from a letter to Fierz on November 26, 1949 (PLC 0092. 063). A month earlier Pauli had written:

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Schwieriger ist der zweite Gegenstand Ihres Briefes, nämlich die Ideen von Jung über "Synchronizität" etc. Als ich ihn Ende Juli besuchte (seitdem habe ich ihn weder gesehen, noch ihm geschrieben), hob er speziell als wichtig hervor, dass er "Kausalität" auf in Raum und Zeit befindliche, "konkrete" oder

"messbare" Ursachen beschränken wolle (um so etwas wie "magische" oder "symbolische" u. ausserhalb Raum u. Zeit befindliche Ursachen *nicht* in den Kausalitäts-begriff miteinzubeziehen). Das ist natürlich ein sehr entscheidender Punkt, denn nur in diesem Sinne sind Schopenhauers "Querverbindungen" gleichartiger Ereignisse "akausal".

Mir selbst scheint bei den sogenannten "synchronistischen" Phänomenen noch wesentlicher, dass dabei Faktoren mitspielen (in sehr provisorischer Weise "Bewusstseinslage" und "archetypische Wirkungen" genannt), die sich einer Kontrolle so weit entziehen, dass eine absichtliche Reproduzierbarkeit dieser Phänomene nicht vorhanden ist (daher auch ihr Zusammenhang mit dem Schicksal, der Heimarmene, dem "χρόνος" und der Tyche).

PLC 0092.065

In an anniversary publication dedicated in honor of C.G.Jung's 80th birthday in 1955, Pauli wrote an article entitled "Naturwissenschaftliche und erkenntnistheoretische Aspekte der Ideen vom Unbewussten" (Scientific and Epistemological Aspects of the Ideas Concerning the Unconscious). Synchronicity is mentioned here only briefly at the end of the article:

Schopenhauer spricht metaphysisch vom "Willen", der Raum und Zeit, das "principium individuationis", wie er diese nennt, durchbricht, und stellt den "nexus metaphysicus" dem gewöhnlichen "nexus physicus" gegenüber. *Jung* verwendet statt der philosophisch-metaphysischen eine psychologisch- naturwissenschaftliche Terminologie. Er versucht die parallelistischen Zusammenhänge auf solche *relativ seltenen* "Randphänomene" (1) zu verallgemeinern und spricht in diesem Fall von einem "Zusammenhang (nexus) durch Gleichartigkeit oder 'Sinn'". Seiner psychologischen Intuition folgend stellt er eine Verbindung mit dem Zeitbegriff her, indem er hierfür den Terminus "Synchronizität" einführt. Hier handelt es sich um einen ersten Versuch des Vordringens in ein sehr neues Gebiet; die Idee von *Jung* ist bisher noch wenig mit empirischen Ergebnissen über ESP im Einzelnen konfrontiert worden.

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Zusammenfassend möchte ich darauf hinweisen, dass es eben die Übereinstimmung des *Sinnes* der etwa gleichzeitig in ver-

schiedenen Wissenszweigen auftretenden Ideen, ihre sinngemässe Koinzidenz, ist, von der ich mich in diesem Artikel ausserhalb meines engeren Spezialgebietes habe leiten lassen: "Korrespondenz (Entsprechung)", "komplementäre Gegensatzpaare" und "Ganzheit" treten sowohl in der Physik als auch in den Ideen vom Unbewussten unabhängig auf. Das "Unbewusste" selbst hat eine gewisse Analogie zu "Feld" in der Physik und beide werden durch ein Beobachtungsproblem wesentlich ins Unanschauliche und Paradoxe gerückt. In der Physik ist zwar nicht die Rede von sich reproduzierenden "Archetypen", sondern von "statistischen Naturgesetzen mit primären Wahrscheinlichkeiten", aber beide Formulierungen treffen sich in der Tendenz, die alte engere Idee von "Kausalität (Determinismus)" zu einer allgemeineren Form von "Zusammenhängen" in der Natur zu erweitern, worauf auch das psychophysische Problem hinweist. Diese Betrachtungsweise lässt mich erwarten, dass sich die Ideen vom Unbewussten nicht im engen Rahmen ihrer therapeutischen Anwendungen weiterentwickeln werden, sondern dass ihr Anschluss an den allgemeinen Strom der Naturwissenschaft der Lebenserscheinungen für sie entscheidend ist.

(1) Ich möchte hier die Frage aufwerfen, ob die von *Rensch* angenommenen, auch dem anorganischen zugesprochenen, primitivsten "psychischen" Komponenten sich nicht gerade in solchen Randphänomenen äussern.

Pauli has adapted Jung's concept of the collective unconscious, and this is expressed--as Pauli specifically tries to illustrate--in a simultaneous appearance of analogous ideas in different fields of study, one example of which is the concept of the "unconscious" which appears in psychology and the general acceptance of the concept of the "field" in physics in the 19th century. Pauli considered these sorts of coincidences in time to be very interesting. Instead, he used the concept of "synchronicity" very cautiously.

Pauli's possibly last remarks on "synchronicity" were expressed in a letter to Fierz on March 5, 1957:

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Über die Frage, "wo das Leben beginnt", dachte ich nach im Zusammenhang mit einem Buch über Evolution des deutschen Zoologen *Rensch* (ich habe es zitiert in dem Dialectica-aufsatz zu Jungs 80.Geburtstag). Dieses Buch ist linientreunodarwinistisch geschrieben; jedoch hat der Autor besondere Ansichten über die Beziehung von Physischem zu Psy-

chischem, die ich anregend fand. (Übrigens sind diese von dem deutschen Psychiater *Ziehen* beeinflusst). Insbesondere meint R., die "psychischen Parallelkomponenten" könnten doch unmöglich in der sonst stetigen Ontogenese "plötzlich aufgesprungen" sein. Also müsste schon die sogenannte unbelebte (nicht-organische) Materie "schwache psychische Parallelkomponenten" aufweisen. Diese Schlussfolgerung schien mir vernünftig, jedoch gab der Autor nicht an, in welchen Phänomenen sich diese schwachen Komponenten denn äussern könnten.

Ich habe mir "für den Hausgebrauch" die Idee gebildet, dass sich diese (und damit das Leben) *zunächst in nicht-reproduzierbaren* Phänomenen äussert, aus denen also zunächst keine induktiven Schlüsse gezogen werden können.

Es ist dies wahrscheinlich dasselbe, was C.G.Jung "inkonstanter Zusammenhang durch Kontingenz" und auch "Synchronizitätsphänomen" nennt. Sagen wir kurz " Σ -Phänomene". Sie mögen Anlass geben zur Folgen mit "Signifikanzen" (im Sinne der Statistiker), die weder Zufallsfolgen sind (denn eine Wahrscheinlichkeit existiert nicht), noch gesetzmässig (denn eine Gesetzmässigkeit ist nicht reproduzierbar). Vom Standpunkt der auf Wahrscheinlichkeitsrechnung basierten Statistik (bezw. von deren Vertretern) bedeuten diese "spurious significances" "überhaupt nichts". D.h. dem traditionellen Naturwissenschaftler gehen sie "durch die Maschen seines Netzes".

So stelle ich mir den "Beginn des Lebens" vor, wobei sich mikroskopisch die Σ -Phänomene als "chemical patterns" äussern könnten.

Ich habe den Eindruck, dass die ESP-Leute (Rhine, Soul etc.) etwas ähnliches beobachten.

Nun möchte ich Ihnen die Frage vorlegen nach den *Beziehungen* dieser Ideen zu denen Ihres Briefes.

Mir scheinen diese nämlich durchaus vorhanden! Die *Gödelsche Formel* erinnert mich sehr an diese Σ -Phänomene, bei denen der Wahrscheinlichkeitsbegriff aufhört. Könnte es so sein, dass es sich nicht entscheiden lässt, ob diese Phänomene den Gesetzen des "anorganischen" widersprechen oder nicht?

Ihr anderes *Motiv*, das *Möbiussche Band* könnte etwas zu tun haben mit dem Verlauf der Lebensprozesse im Grossen. Die Σ -Phänomene stelle ich mir nämlich immer nur als *Durchgangsstadium* vor, als temporär. Es tritt dann wieder irgendwo eine *kausale Fixation* ein, welche diese quasi überflüssig macht und den weiteren Verlauf festlegt. Diese Fixation stelle ich mir so

vor, dass sie vom Standpunkt der gewöhnlichen physikalisch-chemischen Gesetze aus zwar stets "möglich" sein muss, dass sie gemäss diesen Gesetzen jedoch mehr oder weniger unwahrscheinlich wäre.

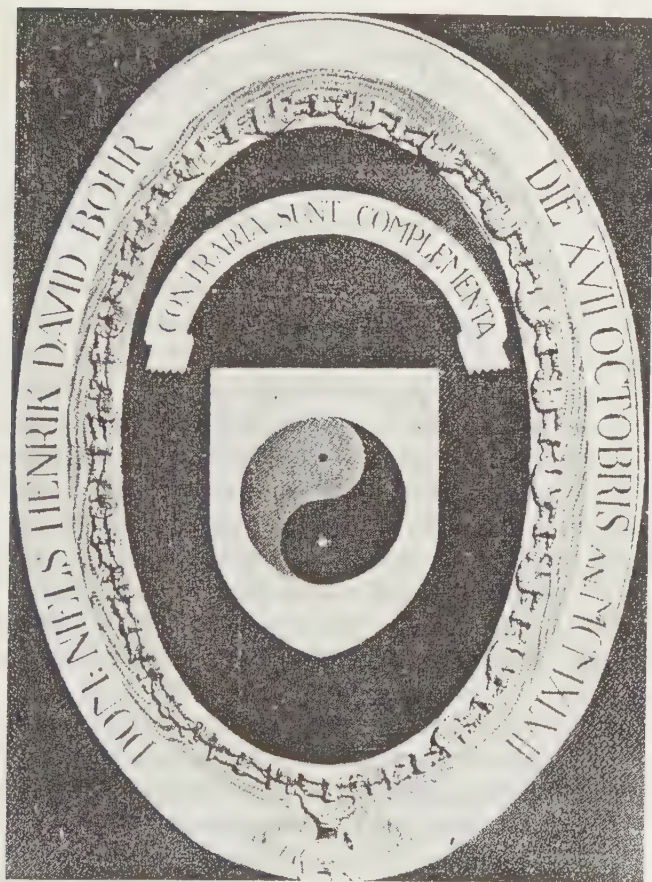
Dann kommen wieder gelegentlich Σ -Phänomene anderer Art etc. Im Ganzen gesehen könnten also die Σ -Phänomene und die kausalen Phänomene wie die 2 Seiten eines Möbiusschen Bandes sein und eben als Ganzes das Leben ausmachen.

Wie reagieren Sie auf diese "Auslegung" Ihres Briefes? Spricht es Sie an? Fällt Ihnen noch etwas dazu ein?

PLC 0092.200

Pauli thus conceives the " Σ -phenomena" in the phenomena of life to be another essential side comparable with causal phenomena. They are mixed into the paths of causally regulated events in such a way which is impossible to govern with the aid of any regularity.

It appears at this point that Pauli has abandoned the idea of "synchronicity" and thus the idea that non-causal events would nevertheless be controlled by some kind of regular "correspondence". It can only be asserted that something participates in the occurrences which cannot in any way be described by any laws, while simultaneously the causal laws of physics and chemistry are valid without exception. This is how I understand Pauli's description of the " Σ -phenomena". The essence of it is that man's knowledge, which is based on a search for regularities, is not able to describe everything which takes place.



Niels Bohr's coat of arms in the Danish Elephant Order, with the Taoist Yin-Yang symbol.
(By permission of the Niels Bohr Archive)

Mysticism

Another Way

Atheism has been strengthened in the Western world to an unbelievable extent in the wake of natural sciences in the Modern Ages. The Christian Church has not been able to respond to the challenges of the day, but rather, the influence of religion on people has noticeably weakened. For an increasing number of people--particularly educated ones--religion has become a very foreign thing.

The matter was increasingly influenced by the formation of state schools. Through this education, people today learn to make demands with respect to knowledge which the fundamental truths of the Christian faith are unable to satisfy. Many have rejected religion totally on the basis of such "scientific requirements", and thus science has to take the responsibility as founder of the world view. Some conceptions analogous to religious perspectives are actually always needed even in pure science, although people generally remain more or less unaware of them; these views are considered to be "scientific". A typical example is the materialistic world view.

Pauli could not accept such development. He very strongly felt it to be dangerously one-sided and his search within the history of ideas included an explicit attempt to also understand *another way to truth*, that represented by religion. He emphasized the limits of scientific knowledge and the irrationality of reality while at the same time attempting to intellectually understand a view of life based upon a religious foundation. In the polemics between Kepler and Fludd which Pauli described in his article on Kepler (cf. p. 79 ff.) he found that Fludd's attitude was more appealing to him than Kepler's one-sidedly logical perspective. Here we come to a field where an appeal to intuition is needed. In the description of such matters the choice of words is decisive. For this reason, it will be important to use as much of Pauli's own text as possible, in spite of the fact that this introduces Pauli's own characteristic expressions, a proper understanding of which may demand a knowledge of quantum mechanics, psychology and the history of ideas. I will attempt to make explanatory comments only

with caution, in order that Pauli's genuine thoughts would be truly expressed.

As a suitable introduction to the problematics we are dealing with now, we can take an excerpt from a letter of Pauli's to Fierz on January 19, 1953:

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Was könnte ich noch deutlicher sagen von dem, was in meinem Kepleraufsatz enthalten ist? Ja, ist es denn dort wirklich nur angedeutet? Einiges weiss ich schon lange:

1.) Fludd steht für die Gegenposition zu den Naturwissenschaften.

2.) Ich selbst bin nicht nur der Kepler, sondern auch der Fludd. Aber - wie Herr Panofsky das so klassisch ausgedrückt hat: ich kann eben "den Kepler nicht mit den fluctibus ausschütten" (NB. weder mit dem Fludd noch mit dem Ganges)

3.) Der Gegensatz Kepler - Fludd spiegelt sich (auf der Subjekt-stufe) wieder in den Gegensätzen

Protestantismus	- - -	Katholizismus
Physik	- - -	Psychologie
Naturwissenschaftliches Denken + Empfinden	- - -	Intuitives Denken

Leute wie Zimmer, A.Huxley oder Wicheler stellen für mich die rechte Seite dieser Aufstellung *allein* dar, ohne die linke. Sie sind daher für mich lehrreich, aber für die Conjunctio ungenügend. Das Gleiche gilt für Indien, Laotse etc.

All dies spielt auch seit langem in meinen Träumen eine Rolle. [Dort wird er zuweilen auch geographisch durch Italien - Holland wiedergegeben, mit Zürich in der Mitte.]

Gesucht ist ein Konjunktionsvorgang (Gegensatzvereinigung), aber der ist mir nur sehr teilweise gelungen. Doch trat erst eine exotische Frau (Chinesin mit Schlitzaugen), später auch ein fremder, helldunkler Mann als Traumfigur auf, der über die gesuchte Gegensatzvereinigung etwas zu wissen schien.

Die Träume betonen die *objektive* Bedeutung der Gegen-satzposition zu den Naturwissenschaften in Form einer "Berufung" als "Professor" an eine Hochschule, manchmal ist diese eine *neue* Hochschule, oft aber unser Zürcher Poly, an das ich dann eben erst einen "Ruf" habe, den ich charakteristischer

Weise noch nicht angenommen habe - oder der fremde Mann will zum Studium am Poly aufgenommen werden, stösst aber dort (d.h. bei der konventionellen, heutigen Wissenschaft) auf Widerstände⁽¹⁾.

Ich bin davon überzeugt, dass diese sich mit Variationen über viele Jahre erstreckenden Traum motive nicht nur mit meiner persönlichen Stagnation etwas zu tun haben, sondern auch objektiver mit den tieferen Gründen der Stagnation der Physik. Leider bin ich *auch* davon überzeugt, dass die Aufgabe, solche Träume zu verstehen und zu deuten, die Fähigkeiten sämtlicher Psychologen unserer Zeit bei weitem übersteigt. Ich halte es auch nicht für primär so wichtig, *Träume* zu diskutieren; ich halte es im Gegenteil für wichtig, das Problem der *Objektivität der Gegenposition zu den Naturwissenschaften selbst direkt zu diskutieren*.

Und es ist *dieses* Problem, das hinter meinem Kepleraufsatz steht. Manchmal meine ich, ich werde zur ersehnten Conjunctio nur kommen können, wenn ich etwas sagen oder formulieren könnte, was sowohl die Vertreter der konventionellen Religion, als auch die Vertreter der konventionellen Wissenschaft sehr chockieren würde. Aber ich weiss noch nicht genau, was es eigentlich ist.

(1) Es traten auch Träume auf, wo ich vor fremden Leuten in einem Auditorium eine Vorlesung halten soll.

PLC 0092.106

"The Struggle Towards Wholeness in Physics" and the "Natural Science--Emotional-Intuitive Counterposition" Conflict (Das "Ganzheitsstreben in der Physik" und der Konflikt "Naturwissenschaft--gefühlsmässig-intuitive Gegenposition")

Evidently, soon after writing the letter quoted above, Pauli sent Fierz an article with this title (no. 0092.107 in the Pauli Collection). It is worth quoting in parts:

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Das Wort "Ganzheit" wird in letzter Zeit von Bohr regelmässiger und häufiger gebraucht, stets im Zusammenhang mit "Komplementarität", unter anderem auch *innerhalb der Physik*. Letzteres geschieht, wenn er von der Ganzheit und

Unteilbarkeit einer in der Quantenmechanik betrachteten Versuchsanordnung spricht. Diese Ganzheit und Unteilbarkeit will er ja in die Definition des "Phänomens" mit aufnehmen, da die Beobachtung die Verbindung der Phänomene "irrational" unterbricht. Es ist diese Irrationalität der Beobachtung, welche die Ψ -Funktion verhindert, "platonisch" - d.h. in einem "metaphysischen Raum" - zu bleiben. Durch sie wird die "Wirklichkeit" der Ψ -Funktion "symbolisch", was etwas ganz anderes ist als "kristallklar", sehr zum Schmerz von Spinozisten (Einstein), Cartesianern (de Broglie) und intellektuellen Aestheten (Schrödinger).

Bohr ist typisch antiplatonisch (vgl. hierzu seine Komplementarität von "Klarheit" und "Wahrheit") und möchte nun in der "Komplementarität", wie sie in der Physik auftrat, *ein allgemeines Modell für Konfliktlösung, für Vereinigung der Gegensatzpaare* - ich selbst sage gerne *Conjunctio* - sehen. Er versuchte dies zum Beispiel auf die Ethik (gut - böse, Gerechtigkeit - Liebe) insbesondere aber auf den Gegensatz Physis - Psyche (psycho-physisches Problem) anzuwenden. Der zentrale Punkt dabei ist bei ihm immer die *Beobachtung*.

Warum hat nun Bohr eine so ausserordentlich starke Aversion gegen den Begriff das "Unbewusste"? Von Persönlichem ganz abgesehen, bringt er immer wieder vor, dass bei der Anwendung dieses Begriffes in der Psychologie des Unbewussten die Rolle der Beobachtung zu wenig in den Vordergrund gerückt ist. Er sagt, man solle auch in dieser Psychologie betonen, dass nach jeder Beobachtung ein *neues* Phänomen einsetzt. Er wittert hier sofort eine gewisse Gefahr, dass der Begriff des "Unbewussten" die Tendenz hat, sich "platonisch" in einen "metaphysischen Raum" zurückzuziehen. Das die Wirklichkeit gültig und adäquat ausdrückende Symbol muss vielmehr - anders als die klassische Physik und z.B. ihr Feldbegriff - den irrationalen Eingriff der Beobachtung und seine Folgen als Potentialität bereits *mit*-ausdrücken.

In *diesem* Sinne nur kann das "Ganzheitsstreben in der Physik" ein *Modell* (wenn Sie wollen, eine "Präfiguration") für den grösseren Konflikt Kepler - Fludd sein. Persönlich ist nicht der Gegensatz zu objektiv! Was ich mit "*objektiver* Bedeutung der Gegensatzposition zu den Naturw." meine, ist der Gegensatz zu *privat*. Eine Berufung an eine Hochschule zum Beispiel ist persönlich, aber nicht *privat*. Auch Persönliches kann *für die*

Öffentlichkeit, für die Allgemeinheit, für ein Publikum von Interesse sein. *Dieses* scheinen mir die in Rede stehenden Träume zu betonen und *dieses* habe ich als "objektiv" bezeichnet. Die Gegensatzposition zu den Naturwissenschaften ist also *nicht privat*, sie mag sehr wohl *persönlich* sein. In der Tat ist ja jedes Fühlen persönlich, wenn auch wiederum das Fühlen ebenso allgemein verbreitet ist wie das Denken. Vielleicht *ist* "Persönlichkeit" eben gerade jener einmalige irrationale Eingriff in die Phänomene, der in der "objektiven" naturwissenschaftlichen Beschreibung nur als Möglichkeit symbolisch ausgedrückt sein kann.

Was ich im Kepleraufsatz sagen wollte ist nur: die moderne Physik in ihrem Ganzheitsstreben gibt ein Modell für die Gegensatzvereinigung (Conjunctio). *Das Problem Kepler - Fludd ist als Konflikt heute wieder an die Oberfläche gekommen und verlangt eine Conjunctio, sowohl in der Welt der Ideen als im Leben konkreter Persönlichkeiten.*

Über diese "grössere" Conjunctio ("grösser" verglichen mit der zwischen Welle und Teilchen) würde ich selbst gerne mehr wissen. Aber das "Modell im Kleinen", im Rahmen der Quantenphysik, war, glaube ich, das Beste, was ich in dem Aufsatz darüber sagen konnte.

Vielleicht kann man sagen: die (nicht-klassische) Naturwissenschaft ist die rationale, objektive, symbolische Beschreibung der *Möglichkeiten* des Einmaligen¹. Die Gegensatzposition hierzu ist die irrationale *Aktualität* des Einmaligen selbst.

Die Träume scheinen zu sagen: die Wirkung der letzteren ist bedeutungsvoll für die allgemeine Öffentlichkeit. Es ist wie wenn die irrationale Aktualität des Einmaligen in meinem Falle der allgemeinen Öffentlichkeit zu stark *vorenthalten* würde; die Träume scheinen hierzu *kompensatorisch* zu sein.

Interessant ist mir weiterhin, dass bei Beginn der Naturwissenschaft tatsächlich in gewissem Sinne die Trinität vom Himmel herabgestiegen ist und zwar *in die Natur* (aber *nicht* in den *Menschen*?!) So habe ich Keplers Kugel und seinen "Hang zum Sonnenkult" (wie B.Russell und andere sagen) eigentlich aufgefasst. (In dieser Verbindung ist mir auch Giordano Bruno lehrreich. Die logische Konsequenz dieser Veränderung ist nämlich der Pantheismus, bei Kepler mit Hilfe der Idee der "signatura rerum" eben noch vermieden.)

In der Frührenaissance, so scheint mir, wollte noch das vom Christentum unterdrückte *Dunkle*² heraus (allerdings nicht im Neuplatonismus), aber was dann im 17. Jahrh. erfolgte (von Galilei bis Descartes), war im Gegenteil die Ausdehnung des Bereiches des lichten Gottes in die (durch die Kausalität erleuchtete) neu erkannte Ordnung der Natur.

Heute erst sind wir wieder beim Dunklen, beim Bösen und beim Akausalen, also bei dem, was sich der Einordnung in Gesetzmässigkeiten entzieht.

Für mich bleibt *Bohr* der Lehrer und Denker, der mir den Gegenpol zum "kristallklaren" Platonismus begreiflich gemacht hat. Er lehrte mich (schon in den 20er Jahren), das Gegensatzpaar "Klarheit - Wahrheit" erkennen, auch das Gegensatzpaar "Instinkt - Vernunft" (wie er das nannte; es war in Verbindung mit Schmidt's Experimenten über die Wanderung der Aale) und er zeigte uns *immer*, wie die Aktualität des Einmaligen (sei es der Beobachtung, sei es des individuellen Lebens) die Anwendbarkeit und Ausdehnung *eines* der beiden Elemente eines Gegensatzpaares auf Kosten des anderen jeweils begrenzt, wie daher jede Philosophie mit einer *Paradoxie* beginnen *muss*! (Neuerdings wird von englischen Autoren - ich glaube von Scherrington - Platos Staat als faschistischer Humbug kritisiert - wie mir scheint, nicht ganz mit Unrecht.)

(1) Dahingegen Einstein: "Physik ist die Beschreibung des Wirklichen" und mir gegenüber fügte er einmal sarkastisch hinzu: "Oder wollen Sie sagen, Physik sei die Beschreibung dessen, was man sich bloß einbildet?" - und Einstein sagt auch "Mit lauter 'Vielleicht' kann man keine physikalische Theorie machen".

(2) Es *erschien* damals als eine Wiederbelebung der Antike, aber inzwischen war viel Zeit vergangen und auch das Dunkle war nicht mehr der alte Dionysos.

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Explanatory Comments

1) The "struggle for wholeness", mentioned in the beginning of the article, and the corresponding definition of a "phenomenon" means, amongst other things, that the observation of a "phenomenon" always includes both *preparation* and *registration*. With the aid of suitable experimental arrangements the systems to be investigated must first be

"prepared in a given state". This kind of state is described by a wave function characteristic of quantum mechanics; for this reason it is normally referred to as a *state function*. On the other hand, an observation always involves some sort of registration by using photographic film, for instance, or an ionization chamber or electronic devices.

A state function serves here as a theoretical tool which connects the preparation and registration stages to one another. It is an expression of causality, on the basis of which it is possible to make certain predictions regarding registration. It is characteristic of the causality in microphysics that it does not correspond to the idea of determinism (absolute causality): the wave function must be interpreted as a probability function with the aid of which only statistical predictions can be presented (causality is statistical).

At first Bohr tended to emphasize that the wave function was only *symbolic* in nature. It represents "our knowledge" after the preparation of the system in question. This contains indirectly *an idea of the observer* who performs the experiment. The observer plans somekind of experimental situation, on the basis of which every system "is prepared in a given state". The wave function contains all information which we have about a prepared system, on the basis of which we can present certain probability expectations.

When an observation is completed with the aid of a certain registration, an irrationality characteristic of observations is always encountered, namely, individual results cannot be predicted unambiguously. The matter is a result of the macrophysical nature of the experimental equipment. Macrophysical devices and their interaction with the systems to be investigated are needed in both preparation and registration. This interaction always contains *irreversible* changes which take place only in a given time direction. The quantum or particle to be observed can, for example, discharge a chemical process on film, the outcome of which is a black spot at a certain place on the film. This process is irreversible: it can never take place in reverse in such a way that the chemical energy of the process would recreate the original particle or quantum, giving it the energy corresponding to the original state. It is these irreversible interactions which are the origin of the incalculability, that is, the *irrationality* which is inherent in microphysical observations. It is explicitly characteristic of *observations* through which microphenomena become visible to us.

Various theoretical methods of investigation have been presented which seek to conceal the irrationality under a cloak of rational description. Pauli has mentioned the most important motives behind this seeking of a way differing from the Copenhagen philosophy in the beginning of his article: "Spinozism", that is, faith in the determinism of the world;

"Cartesianism", *i.e.*, trust in the completely logical nature of reality; and finally, an attempt at a *monistic* picture of the world; in Schrödinger's case this meant the hope that one would finally be able to govern all microphysical phenomena with the aid of a wave description.

In materialism, which is an explicitly monistic picture of the world, these tendencies characteristic of classical physics are clearly seen. For this reason, Fock wanted Bohr to slightly alter his manner of expression in the description of the interpretation of quantum mechanics (p. 58-59). Thus, he did not like the wave function being referred to as something symbolic. Fock wanted to consider it as an "element of reality", and not just as something expressing "our knowledge" of the system under investigation. But it was exactly these small alterations in verbal expression which made the revolutionary character of the Copenhagen interpretation hazy; Pauli's thought, instead, expressed it with the greatest clarity. (A more detailed discussion of this is found in Appendix I).

2) After an analysis of certain dreams of his, Pauli came up with the idea that they compensate for some kind of instinctual repression which he exercised in regard to an attitude complementary to natural sciences. This kind of repression is quite common amongst natural scientists. Particularly in Western countries, the dominating way of thought is to strongly oppose any kind of *conjunction* between natural sciences and mysticism, something which was central to Pauli's thought but which he spoke about publicly only very seldom. His correspondence with Fierz is exceptional in the sense that in it he dealt extensively with exactly those "repressed" matters. Aside from his article on Kepler in 1952, his lecture at Mainz (1955) was really the only *publication* in which Pauli treated his views of the conjunction between knowledge and faith, and such a terse presentation was not sufficient to draw much attention to his ideas. In addition, the question of understanding the German language raises difficulties for many nowadays.

An interesting addition to the above-mentioned dreams will be presented in the next chapter (p. 122). Pauli also told Fierz about certain other dreams of this kind.

3) Pauli continually struggled with the question regarding the relation of natural science to the intuitive position complementary to it. Pauli was himself a great artist of mathematical natural science but he "was not only Kepler, but also Fludd". The intuitive counter-position is explicitly associated with the "struggle towards wholeness", the need of which Pauli experienced very strongly. In place of the strong repression of all ideas related to the complementary element of reality by the materialists and most natural scientists alike, during the 50's Pauli considered the unification of this element with the natural scientist's world view to be a burning issue,

encouraging him on into an extensive work of clarification in the history of ideas and philosophy.

Reality can be approached in two different ways: either via more and more detailed information obtained through the aid of scientific analysis, or by striving for a comprehension of wholeness. The latter is the path of poets, musicians and other artists, as well as practicers of religion and mysticism. From the point of view of life as a whole, both ways are necessary. The questions concerning choices, values, and morality demand more, perhaps, the comprehension of wholeness than logical analysis and thorough experience.

Both of these attempts at understanding reality are a part of culture. The purest expressions of these attempts are, perhaps, exact natural sciences and mysticism. Pauli acknowledged the need for both ways, and he pursued their unification--or conjunction. For this reason he also tried to thoroughly comprehend mysticism and phenomena related to it. Jung's psychology was of great help to him in this regard.

Die Wissenschaft und das abendländische Denken (1955)

In order to shed light on Pauli's way of thought it is worth while to quote rather extensively the lecture given in Mainz. In its beginning, Pauli considers the significance of mathematics and natural science in Western culture, investigating the problematics of *the relation between the knowledge of salvation (Heilserkenntnis) and scientific knowledge*. He alludes to the fact that the representatives of mysticism in the West (Master Eckhart, for example) and in the East (such as the Hindu Shankara) have all described reality in a very similar form.

209 Die Mystik sucht die Einheit aller äusseren Dinge und die Einheit vom Innern des Menschen mit ihnen, indem sie die Vielheit der Dinge als Illusion, als unwirklich zu durchschauen sucht. So entsteht von Stufe zu Stufe die Einheit des Menschen mit der Gottheit, in China das Tao, in Indien Samadhi oder buddhistisch Nirwana. Die letztgenannten Zustände kommen, abendländisch betrachtet, wohl der Auslöschung des Ichbewusstseins gleich. Die konsequente Mystik fragt nicht: "warum?" Sie fragt: "Wie kann der Mensch dem Übel, dem Leid dieser schrecklichen, bedrohenden Welt entgehen, wie kann sie als Schein erkannt, wie kann die letzte Wirklichkeit, das Brahman, das Eine, die (bei Eckhart nicht mehr persönliche) Gottheit geschaut werden?" Es ist dagegen wissenschaftlich-abendländisch, in gewissem Sinne kann man sagen griechisch,

zum Beispiel zu fragen: "Warum spiegelt sich das Eine im Vielen? Was ist das Spiegelnde und was das Gespiegelte? Warum ist das Eine nicht allein geblieben? Was verursacht die sogenannte Illusion?"----Ich glaube, dass es das Schicksal des Abendlandes ist, diese beiden Grundhaltungen, die kritisch rationale, verstehen wollende auf der einen Seite und die mystisch irrationale, das erlösende Einheitserlebnis suchende auf der anderen Seite immer wieder in Verbindung miteinander zu bringen. In der Seele des Menschen werden immer *beide* Haltungen wohnen, und die eine wird stets die andere als Keim ihres Gegenteils schon in sich tragen. Dadurch entsteht eine Art dialektischer Prozess, von dem wir nicht wissen, wohin er uns führt. Ich glaube, als Abendländer müssen wir uns diesem Prozess anvertrauen und das Gegensatzpaar als komplementär anerkennen; wir können und wollen das die Welt beobachtende Ichbewusstsein nicht gänzlich opfern, wir können aber das Einheitserlebnis als eine Art Grenzfall oder idealen Grenzbegriff auch intellektuell akzeptieren. Indem wir die Spannung der Gegensätze bestehen lassen, müssen wir auch anerkennen, dass wir auf jedem Erkenntnis- oder Erlösungsweg von Faktoren abhängen, die ausserhalb unserer Kontrolle sind und die die religiöse Sprache stets als Gnade bezeichnet hat.

Vor dem rational eingestellten *Demokrit* wirkte bereits der schon erwähnte *Pythagoras* (um 530 v. Chr.). Er und seine Schüler gründeten eine ausgesprochen mystische Heilslehre, die aufs innigste mit mathematischem Denken verbunden war und auf der älteren babylonischen Zahlenmystik fusste. Für ihn und die Pythagoräer ist überall, wo die Zahl ist, auch die Seele, Ausdruck der Einheit, die Gott ist. Ganzzahlige Verhältnisse, wie sie in den Proportionen der Schwingungszahlen der einfachen musikalischen Intervalle auftreten, sind Harmonie, d.h. das was Einheit in die Gegensätze bringt; als Teil der Mathematik gehört die Zahl auch einer abstrakten, übersinnlichen ewigen Welt an, die nicht mit den Sinnen, sondern nur kontemplativ mit dem Intellekt erfasst werden kann. So ist bei den Pythagoräern Mathematik und kontemplative Meditation (die ursprüngliche Bedeutung von "theoria") aufs engste verbunden, mathematisches Wissen und Weisheit (*sophia*) sind für sie nicht zu trennen. Eine spezielle Bedeutung hatte die Tetraktys, die Vierzahl, und ein Schwur der Pythagoräer ist überliefert: "Bei dem, der unserer Seele die Tetraktys überliefert hat, den Urquell und die Wurzel der ewigen Natur".

Als Reaktion gegen den Rationalismus der Atomisten hat *Plato* (428-348 v. Chr.) viele mystische Elemente der Pythagoräer in seiner Ideenlehre übernommen. Mit ihnen teilt er seine höhere Wertschätzung der Kontemplation, verglichen mit der gewöhnlichen Sinneserfahrung, und seine leidenschaftliche Anteilnahme an Mathematik, besonders an Geometrie mit ihren idealen Objekten. Die Entdeckungen seines Freundes *Theaitetos* über inkommensurable Strecken (nicht durch rationale Brüche darstellbare Verhältnisse) haben ihn tief beeindruckt. Handelt es sich hier doch um eine wesentliche Frage, die nicht durch sinnliches Wahrnehmen, sondern nur durch Denken entschieden werden kann.

In Weiterbildung pythagoräischer Lehren ist *Platos* Mystik eine lichte Mystik, in der das Verstehen in seinen verschiedenen Graden vom Meinen (δόξα) über das geometrische Wissen (διάνοια) bis zur höchsten Erkenntnis der allgemeinen und notwendigen Wahrheiten (ἐπιστήμη) seinen Platz gefunden hat. Die Mystik ist so licht, dass sie über viele Dunkelheiten hinwegsieht, was wir Heutigen weder dürfen noch können. Dies äussert sich z. B. in der Auffassung des Guten bei *Plato* als identisch mit der in der Meditation erkennbaren höchsten "Wirklichkeit". Des *Sokrates* These von der Lehrbarkeit der Tugend und von der Unwissenheit als alleiniger Ursache böser Taten wird zu *Platos* Lehre von der Identität der Idee des Guten mit der Ursache des Wissens vom Wahren und der Wissenschaft.

Während sich diese rational zum axiomatischen System der Geometrie in *Euklids* Elementen (um 300 v. Chr.) entwickelt, das so lange jeder Kritik gegenüber standhielt und erst im 19. Jahrhundert wesentlich erweitert wurde, geht aus der mystischen Seite *Platos* allmählich der Neuplatonismus hervor, der bei *Plotin* (204 bis 270 n. Chr.) seine einigermassen systematische Formulierung findet. Hier findet man die Identität des Guten mit dem Verstehbaren gegenüber *Plato* selbst ins Extreme gezogen und vergrößert durch die Doktrin, dass die Materie (Hyle) ein blosses Fehlen (privatio) der Ideen, dass sie überdies das Böse sei und dieses daher eine blosser privatio boni, ein Fehlen des Guten, das nicht Gegenstand des begrifflichen Denkens sein könne. So entstand eine recht bizarr erscheinende Vermischung des ethischen Gegensatzpaares "gut - böse" mit dem naturalistischen oder logischen "seiend - nicht seiend", das wir am ehesten durch "rational - irrational" wiedergeben können.

Mehr als andere philosophische Strömungen der Spätantike erwies sich die neuplatonische als geeignet zur Aufnahme in die frühchristliche Theologie. In der Tat war *Augustin* vor seiner Bekehrung zum Christentum Neuplatoniker, und seither gab es stets mehr oder weniger platonisierende Theologen und Philosophen unter den christlichen Denkern.

After this Pauli describes the development during the Italian Renaissance and the 17th century which, amongst other things, gave birth to modern natural science. A matter particularly central to this development was the application of mathematics to nature. It displayed--particularly in the context of Neoplatonism which contained mystical elements--a factor unifying the picture of the world, but the nature of the development changed with the passage of time. In the conclusion of his article Pauli describes this change and the developments which followed it up until the present situation.

Zu den allgemeinen charakteristischen Erscheinungen des 17.Jahrhunderts gehört die Wiederherstellung neuer Schranken zwischen den einzelnen Disziplinen und Fakultäten und die Spaltung des Weltbildes in die rationale und die religiöse Seite. Diese Dissoziation war unvermeidlich und spiegelt sich sowohl in der Philosophie *Descartes'* als auch in *Newtons* theologischen Schriften besonders deutlich wieder.

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Ein ähnliches Schicksal hatte um diese Zeit auch der zweite Versuch einer Synthese zwischen einem Heilsweg mit gnostisch-mystischen Elementen und wissenschaftlicher Erkenntnis, derjenige der Alchemie und hermetischen Philosophie. In alter Zeit beginnend, wird sie in der Spätantike seit dem Erscheinen des *Hermes Trismegistos* sehr verbreitet, zieht sich dann, anfangs von arabischen Quellen und ihren lateinischen Übersetzungen gespeist, durch das ganze Mittelalter, um schliesslich nach einer Blütezeit im 16.Jahrhundert gegen Ende des 17.Jahrhunderts mit dem Beginn der neuzeitlichen Naturwissenschaft zu verfallen. Auch diesmal erwies sich die Basis der Synthese als zu eng, und das Gegensatzpaar fiel wieder auseinander: in die wissenschaftliche Chemie auf der einen Seite und die von materiellen Vorgängen wieder abgelöste religiöse Mystik, z.B. durch *Jacob Böhme* vertreten, auf der anderen Seite.

Die uns zunächst recht fremdartig anmutenden Voraussetzungen der alchemistischen Philosophie stellen eine gewisse

Symmetrie her zwischen Materie und Geist. Dadurch entsteht ein Gegengewicht gegen die einseitig spiritualisierende Tendenz, die der Neuplatonismus gegenüber *Plato* selbst beträchtlich verstärkt hat und die vom Christentum übernommen wurde. Im Gegensatz zur neuplatonischen Identifikation der Materie mit dem Bösen wohnt nach der alchemistischen Auffassung in der Materie ein Geist, der auf Erlösung harrt. Der alchemistische Laborant ist stets mit einbezogen in den Naturlauf in solcher Weise, dass die wirklichen oder vermeintlichen chemischen Prozesse in der Retorte mit den psychischen Vorgängen in ihm selbst mystisch identifiziert sind und mit denselben Worten bezeichnet werden. Fremd ist uns heute die Identifizierung jedes der sieben Planeten mit einem der sieben Metalle, darunter die Identität des Hermes sowohl mit dem Planeten Merkur wie mit dem *argentum vivum*, dem Quecksilber, das auch seinen Namen *mercury* behalten hat. Geblieben ist ferner von den Identifizierungen leicht verdampfender, flüchtiger Substanzen mit Geist der Name *Spiritus* für Alkohol, die Essenz (Wesen) auch für das materielle Resultat der Destillation.

Der Erlösungsweg, auch selbst wieder durch den Hermes symbolisiert, ist ein *opus* (Werk), beginnend mit der Schwärze (*nigredo* oder *melancholia*) und endend mit der Herstellung des *lapis sapientium*, des Steines der Weisen, der als *filius philosophorum* und *filius macrocosmi* zu Christus, dem *filius microcosmi* parallelisiert wird. Die Erlösung des Stoffes durch den ihn verwandelnden Menschen, die in der Herstellung des Steines gipfelt, ist nach alchemistischer Auffassung, zufolge der mystischen Entsprechung von *Macrocosmos* und *Microcosmos*, identisch mit der den Menschen erlösenden Wandlung durch das *opus*, das nur '*Deo concedente*' gelingt.

Es handelt sich bei der Alchemie um einen psychophysischen Monismus, in einer uns sonderbar anmutenden Einheitssprache ausgedrückt, die im konkret Sichtbaren hängen bleibt. Man darf aber die allgemeine, auf das Einheitserlebnis gerichtete Einstellung des Menschen zur Natur, welche die Alchemie ausdrückt, nicht mit deren Auswüchsen einfach identifizieren, zu denen bekanntlich eine stets vergebliche und oft betrügerische Goldmacherei gehörte.

Goethes naturwissenschaftliche Auffassungen, die der offiziellen Wissenschaft so oft entgegengesetzt waren, werden verständlicher durch deren alchemistische Vorlagen, deren Terminologie insbesondere im *Faust* ganz offen zu Tage tritt. Als

einem Gefühlstyp war *Goethe* das Einheitserlebnis--"nichts ist drinnen, nichts ist draussen, denn was innen, das ist aussen"-- zugänglicher als die kritische Naturwissenschaft, und nur die Alchemie kam hierbei seiner Gefühlshaltung entgegen. Dies ist der Hintergrund von *Goethes* Auseinandersetzung mit *Newton*, über die schon viel geschrieben worden ist. Weniger bekannt ist die ältere Polemik zwischen *Kepler* als Vertreter der neuentstehenden Naturwissenschaft und dem englischen Arzt *Robert Fludd*, der dem Rosenkreuzerorden angehörte und die hermetische Tradition vertrat. Ich glaube, man kann auf *Kepler - Fludd* und *Newton - Goethe* mit gutem Recht das alte Sprichwort anwenden: "Was die Alten sangen, das zwitschern die Jungen".

Von der Psychologie des Unbewussten her ist neuerdings *C.G.Jung* daran gegangen, den psychologischen Gehalt der alten alchemistischen Texte auszugraben und unserer Zeit zu erschliessen. Ich hoffe, dass dabei noch einiges wertvolle Material zu Tage gefördert werden wird, namentlich über die Rolle der Gegensatzpaare im alchemistischen Opus. Auch für die Psychologie des Unbewussten bedeutet die Alchemie ein Gegengewicht gegen zu starke Spiritualisierung, sie bedeutet ihre Begegnung mit der Materie und mit der übrigen Naturwissenschaft.

Hier stellt sich für die Naturwissenschaft unserer Zeit die wesentliche Frage: "Werden wir auf höherer Ebene den alten psychophysischen Einheitstraum der Alchemie realisieren können, durch Schaffung einer einheitlichen begrifflichen Grundlage für die naturwissenschaftliche Erfassung des Physischen wie des Psychischen?" Wir wissen die Antwort noch nicht. Viele Grundfragen der Biologie, insbesondere die Beziehung des Kausalen und des Zweckmässigen, und damit auch die psychophysischen Zusammenhänge, haben meiner Ansicht nach noch nicht eine wirklich befriedigende Beantwortung und Aufklärung erfahren.

Die heutige Quantenphysik ist jedoch gemäss der Formulierung *Niels Bohrs* ebenfalls auf komplementäre Gegensatzpaare bei ihren atomaren Objekten gestossen, wie Teilchen - Welle, Ort - Bewegungsgrösse, und muss der Freiheit des Beobachters Rechnung tragen, zwischen einander ausschliessenden Versuchsanordnungen zu wählen, die in einer im voraus unberechenbaren Weise in den Naturlauf eingreifen. Hat er einmal seine Versuchsanordnung gewählt, so ist aber auch für

den Beobachter der heutigen Physik das objektive Resultat der Beobachtung seiner Beeinflussung entzogen. Verschiedene Physiker haben diese für den Laien nicht leicht verständlichen Sachverhalte an anderer Stelle mehrmals ausgeführt und ich kann hier nur kurz darauf hinweisen:

Die alte Frage, ob unter Umständen der psychische Zustand des Beobachters den äusseren materiellen Naturverlauf beeinflussen kann, findet in der heutigen Physik keinen Platz. Für die alten Alchemisten war die Antwort ganz selbstverständlich bejahend. Im letzten Jahrhundert hat ein so kritischer Geist wie der Philosoph *Arthur Schopenhauer*, ein ausgezeichnete Kenner und Bewunderer *Kants*, in seinem Aufsatz "Animalischer Magnetismus und Magie" sogenannte magische Wirkungen sehr weitgehend für möglich gehalten und in seiner besonderen Terminologie als "direkte, die Schranken von Raum und Zeit durchbrechende Einwirkungen des Willens" gedeutet. Daraufhin kann man wohl nicht sagen, dass apriorische philosophische Gründe ausreichend seien, um solche Möglichkeiten von vornherein abzuweisen. In neuerer Zeit gibt es eine empirische Parapsychologie, die den Anspruch exakter Wissenschaftlichkeit erhebt und mit modernen experimentellen Methoden einerseits, mit moderner mathematischer Statistik andererseits arbeitet. Sollten sich die positiven Ergebnisse auf dem noch kontroversen Gebiet der "extra sensory perception" (ESP) endgültig bewahrheiten, so könnte dies zu heute noch gar nicht übersehbaren Entwicklungen führen.

Im Lichte unserer schon aus äusseren Gründen übermässig knapp zusammengedrängten historischen Übersicht können wir sagen, dass die heutige Zeit wieder einen Punkt erreicht hat, wo die rationalistische Einstellung ihren Höhepunkt überschritten und als zu eng empfunden wird. Aussen scheinen alle Gegensätze ausserordentlich verschärft. Das Rationale führt einerseits wohl zur Annahme einer nicht direkt sinnlich wahrnehmbaren, durch mathematische oder andere Symbole aber erfassbaren Wirklichkeit, wie z.B. das Atom oder das Unbewusste. Die sichtbaren Wirkungen dieser abstrakten Wirklichkeit sind aber andererseits so konkret wie atomare Explosionen und keineswegs notwendig gut, sondern zuweilen das extreme Gegenteil. Eine Flucht aus dem bloss Rationalen, bei dem der Wille zur Macht als Hintergrund niemals ganz fehlt, in dessen Gegenteil, z. B. in eine christliche oder buddhistische Mystik, ist naheliegend und

gefühlsmässig verständlich. Ich glaube jedoch, dass demjenigen, für welchen der enge Rationalismus seine Überzeugungskraft verloren hat und dem auch der Zauber einer mystischen Einstellung, welche die äussere Welt in ihrer bedrängenden Vielheit als illusorisch erlebt, nicht wirksam genug ist, nichts übrig bleibt, als sich diesen verschärften Gegensätzen und ihren Konflikten in der einen oder anderen Weise auszusetzen. Eben dadurch kann auch der Forscher, mehr oder weniger bewusst, einen inneren Heilsweg gehen. Langsam entstehen dann zur äusseren Lage kompensatorisch innere Bilder, Phantasien oder Ideen, welche eine Annäherung der Pole der Gegensatzpaare als möglich aufzeigen. Gewarnt durch den Misserfolg aller verfrühten Einheitsbestrebungen in der Geistesgeschichte will ich es nicht wagen, über die Zukunft Voraussagen zu machen. Entgegen der strengen Einteilung der Aktivitäten des menschlichen Geistes in getrennte Departemente seit dem 17. Jahrhundert, halte ich aber die Zielvorstellung einer Überwindung der Gegensätze, zu der auch eine sowohl das rationale Verstehen wie das mystische Einheitserlebnis umfassende Synthese gehört, für den ausgesprochenen oder unausgesprochenen Mythos unserer eigenen, heutigen Zeit.

Perhaps the long sentences at the conclusion of the lecture are a bit difficult to understand, but Pauli evidently still wanted to present his opinion that the archetype of the unification of opposites (conjunction), plays a powerful role in the collective unconscious of our times. He consciously strove to reach a synthesis containing both the rational world view and that of religious mysticism. Unfortunately, a premature death cut short this maturation process which would surely have yielded fascinating and important results--also, among other things, leading the basic research of quantum mechanics into a different direction than it took in the 60's.

PHILOSOPHIA MOYSAICA.

In qua

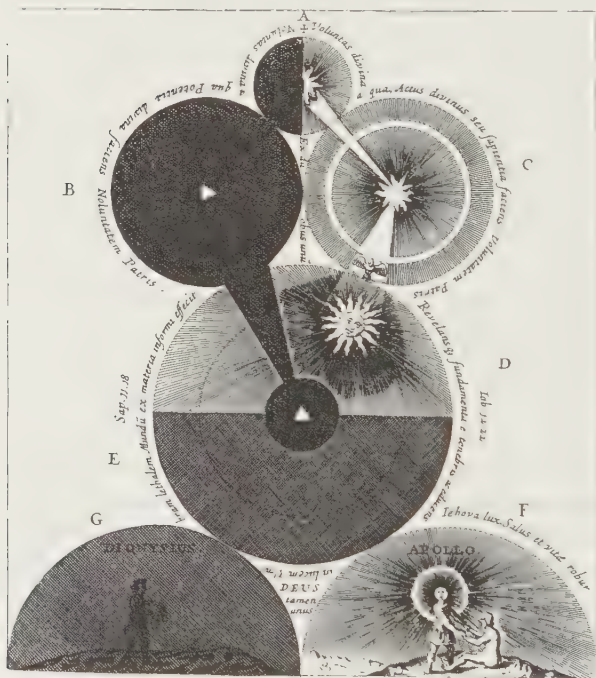
Sapientia & scientia creationis & creaturarum Sacra verèque Chriftiana (vt pote
cujus basis five Fundamentum est unicus ille Lapis Angularis Iesus Chriftus)
ad amosum & enucleatè explicatur.

AUTHORE,

ROB. FLUDD, alias DE FLUCTIBVS,

Armigero & in Medicina Doctore Oxoniensi.

*Christus est imago Dei invisibilis, primo genitus omnis creature, quoniam in ipso condita
sunt universa in calis & in terra visibilia & invisibilia, five Throni, five Dominationes,
five Principatus, five potestates, Omnia per ipsum & in ipso creata sunt:
ipse est ante omnes & omnia in ipso constant. Coloss. 1.5, 16.*



G O V D F

Excudebat Petrus Rammaezus, Bibliopola. Anno. M. DC. XXXVIII.

The title page of Robert Fludd's book *Philosophia Moysaica* (1638), symbolizing the basic opposite of good and evil in the world.
(By courtesy of the Helsinki University Library)

The Problem of Evil

Irrationality and Evil

In reference to the analysis of his own dreams, Pauli mentioned that he instinctively "repressed" the objective significance of the mystical-intuitive attitude, even though the importance of a position which is complementary to natural science had already become clear to him in principle. I understand this repression very well in light of the experiences which I myself have had.

These things shake the core of the traditional ways of thought in different fields: in natural science, in philosophy and in theology. In addition, the conception of man also changes, which has implications, for example, in regard to mental disturbances--even for so-called somatic ones, because the connection of the psyche to physiological events must be emphasized. Severe criticism, often extremely emotional in nature, appears from many different sides. At question is a conflict on the level of archetypes. The sharp reactions show that the change in the concept of causality originating in atomic theory has been a deep one indeed.

There are two matters which seem to be particularly insulting to the basic stands of many: the intermixing of religion and science and talk about the irrationality of reality.

The latter point is partly semantic in nature: what is meant by "rational" and what by "irrational"? Here Pauli has adopted a certain usage of words which has come out already in many connections in this book, particularly in Chapter V, "Spirit and Matter". His terminology is related to some very old ideas in the history of philosophy.

Something is rational according to this terminology if it belongs, or at least in principle can belong to the framework of logically arranged, conceptual knowledge. That which is unattainable even in principle through logically ordered knowledge is irrational.

According to Platonism, as well as Cartesian philosophy, "rational"--in this sense of the word--is "that which truly exists". Reality itself is considered to be rational and so it can most certainly be attained by logical thought. Instead of this, Pauli wanted to emphasize that this concept of

reality is itself wrong because it ignores the irrationality which is always contained in observations. The idea of statistical causality means that a rational description regards only statistical mean values (and the strength of their scatter). Individual events "go through the meshes of its net". This is not merely the result of somekind of insufficiency in the theories currently existing, but of the basic structure of reality itself: reality is rational only in part, in individual events we meet the irrationality of reality. It is incorrect to assume that any logical system whatsoever would perfectly describe reality. The Platonian conception of "that which truly is" is misleading.

Heisenberg's uncertainty relations are concrete expressions of this new concept of reality in atomic physics. The possibility of a rational description is in principle limited. It is necessary to adopt some kind of terminology with the aid of which we can describe the new, non-Platonian view of the fundamental nature of reality. Here Pauli employs the terms "rational" and "irrational". In this sense, the Platonian and Cartesian conceptions of reality are rational, while Pauli's own conception of reality is irrational, although it, of course, also involves a very strong rational component.

It is useless to dispute about whether we are here using the word "irrational" in a correct sense. The main point is that we have some kind of terminology with the aid of which we can express the basic nature of the new conception of reality.

Besides, it is worth noting that all terms used in a rational language express poorly what Pauli means by "irrational". It is, in fact, something which cannot be described in rational terms. In my book, "Luonto puhuu Luojustaan" ("Nature Speaks of Its Creator") I have employed the term "incomprehensible" in its stead. It must be understood here that the incomprehensible "participates" in everything which takes place; human (rational) knowledge can only contain probabilities. This kind of terminology also raises objections, of course, from the side of materialists and atheists.

From now on we shall use the terms "rational" and "irrational" in the sense in which Pauli intended them and which I have tried to describe here. It is important to note now that the term "irrational" relates very closely in Pauli's thought to the concept of "evil"--once again due to reasons stemming from the history of philosophy. It was quite common in antiquity as well as in medieval times to identify "rational" with "good". It was particularly this way in Neoplatonism, where the formula:

rational = truly existing = good

held, because the ruler of the "truly existing" world of ideas and the basis

of the hierarchy of concepts was the idea of good. The truly existing was, thus, of its very nature good. Matter, on the other hand, was irrational, it could not be grasped through knowledge, and at the same time it was evil; or in more exact terms matter was characterized by a *total lack of good* (*privatio boni*).

Aristotelian philosophy had basically the same essential feature. According to it, the fundamental constituents of the world were "form" and "matter". It was possible to know something about form and therefore it was considered rational while "matter", instead, was irrational: it was possible to know something about it only when it was associated with a "form". The idea of *privatio boni* also adapted well to Aristotelian philosophy; Christian philosophy in particular took the view that matter represented the evil and the irrational, for which reason one needed to seek release from it.

Because Pauli hoped for a change in the course of the development of ideas closer to that of the medieval ways of thought, he was very interested in this classical identity:

irrational = evil

Nevertheless, he rejected the Neoplatonian idea of *privatio boni*. The fact that Pauli's concept of reality contained an irrational component meant for him the same as reality containing a truly *active evil* which was not merely a lack of good, but an essential feature of reality.

Thus it was that Pauli was led to wrestle with the question of *the nature of evil and its role in the world*. We can see in the background *an archetype of an outline for reality* which has been essentially influenced by the work Pauli has carried out in the history of ideas. Pauli was a genius who was able to fuse the various fields and modes of expression of human culture into a unified whole. In a world split by the requirements of specialization, he was an exceptional phenomenon creating hope; his unusually extensive expertise gave his views a special vigour.

Personally, I am not ready to completely accept Pauli's viewpoint. I consider Western culture to be more intimately bound to Christianity than the view he presents. Without a doubt, however, those matters which Pauli struggled over in his presentation of the problem of evil powerfully exist in the collective unconscious of our time. In the solution of them one can even see a question of the fate of Western culture. This would explain the outbursts of emotion which take place when the border between science and religion is transgressed.

Lieber Herr Fierz,

Ihr neuer Brief (vom 9.) hat mich wieder sehr interessiert, besonders Ihre "Enthüllung", dass More's Traum ausgerechnet "die letzten Zweifel heben soll, dass Gottes Güte und seine Vorhersehung [Fierz meant, obviously, 'Vorsehung'=providence; K.V.L.] dem Bösen nicht widersprechen". Ich hatte nur aus allgemeinen Indizien erraten, dass das Gut - Böse - Problem wesentlich konstelliert war. - Nun bin ich sehr erfreut, dass die ungeheure *Verdrängung* der "dunklen Seite", die damals stattfand, sich so direkt nachweisen lässt. Die Sache scheint mir nun immer wichtiger.

Ich muss bekennen, dass meine Sympathie bei More's Traum völlig auf der Seite der beiden Esel ist¹ und dass ich (um die Sache der "heiligen Quaternität" zu verteidigen) ihrem Schreien hiermit gerne noch einige weitere Trompetenstösse, auch ausserhalb des Waldes, hinzufügen möchte. Diese sollen *zugleich* ein weiterer Kommentar sein zum Thema Ihres letzten Vortrages im psychologischen Club.

(1) Was More selbst über diese sagt, zeigt nur seine gewaltsame Verdrängung, die der Traum kompensieren wollte.

1. Die Gegenposition der Alchemie zum Platonismus. Fludd.

Anders als bei den Platonikern wurde das Licht - Dunkel - Problem von den Alchemisten des 17.Jahrhunderts eben *nicht* verdrängt und das war und ist es, was mich an *Fludd* so fasziniert. Fludd ist wohl ein Zeitgenosse (oder etwas früher) von More (aus welchem Jahr stammen dessen von Ihnen studierten Dialoge?) und ich habe als Gegenstück zu More insbesondere dessen "Philosophia Moysaica" (erschieden 1637) im Sinne. - Gleich am Anfang findet sich eine polare schwarz-weiße Figur, unter der links "Dionysos", rechts "Apollo" steht. (Ich frage mich, ob Sie diese Figur nicht in Ihrer Arbeit über More - Newton *publizieren* sollten. Sie wäre es wohl wert. Ich konnte das nicht, weil sie zu Kepler keine Beziehung hat.) Soviel ich mich erinnere, findet sich dieselbe Figur auch in Fludd's früherem Werk "Utriusque Cosmi ... Historia", 1621. Während aber in letzterem kein Kommentar zu dieser Figur steht, finden sich in der Phil. Moys. zahlreiche (lateinische) Zitate aus dem alten Testament,

welche illustrieren sollen, dass Gott *auch* die Finsternis (tenebras) bringt und eine *Unheil*seite hat. U.a. steht dort auch das sehr bekannte Zitat aus *Jesaias* 45, 6, 7: "Ich bin Jahwe, und keiner sonst, der das Licht bildet *und Finsternis schafft*, der Heil wirkt *und Unheil schafft*, - ich Jahwe, bin's, der alles dies bewirkt."

Das alte Testament enthält nur das barbarisch-primitive Bild eines launischen Tyrannen, aber die jüdischen Kabbalisten (von denen Fludd direkt beeinflusst war) haben immer versucht, daraus etwas philosophischeres herauszudestillieren [insbesondere *Luria* mit seiner Tsim- Tsum (= Rückzugs)-lehre]. Der launische Tyrann hatte wenigstens "kein Lammschwänzchen" (wie *Heine* seinen Rabbi in der "Disputation" sagen lässt).

2. Die mystische Seite von Plotin. Meister Eckhardt. Negative Theologie.

Diese Übereinstimmung der Mystiker besteht im Postulat einer transzendenten Einheit alles Seins, über die mit menschlichen Begriffen keine weiteren Aussagen gemacht werden können, die unpersönlich oder überpersönlich, "formlos", abstrakt und unanschaulich ist. Bei Plotin ist dies das "Eine", bei Meister Eckhardt "Gott", *unterschieden* von "der Gottheit" (siehe unten). Alle Mystiker sind darüber einig, dass die menschlichen Begriffe "gut" und "böse" sich auf dieses Abstraktum nicht anwenden lassen².--Der Terminus technicus hierfür heisst "negative Theologie".

Plotin sagt in diesem Zusammenhang vom "Einen", dass es "hyperagathon" ("übergut") sei (siehe Plotin VI, 9) und Meister Eckhardt sagt, Gott könne nicht "gut" sein, denn sonst könnte er ja auch "besser" sein.

Ein gelehrter Inder, der Philosoph Radakrishnan versicherte mir, dass kein wesentlicher Unterschied der Vedantalehre von dieser Seite von Plotin sowie von Meister Eckhardt bestünde. Bei diesen beiden Autoren sei die Vedantalehre im Abendland am stärksten angenähert.

Ich habe den Eindruck, dass diese mystische Seite von *Plotin* von den Renaissanceplatonikern (als auch von More)

unterschlagen worden ist (trotz Meister Eckhardt), wahrscheinlich weil sie von der offiziellen Kirchenreligion verschieden ist.

Ich sehe nicht, dass dieses Postulat der Mystiker irgend welchen naturwissenschaftlichen Erkenntnissen widersprechen kann, noch sehe ich, dass es irgendwie mit der Empirie in Konflikt ist. Wohl aber sehe ich, dass man auch dem menschlichen Bewusstsein mehr angenäherte Formen einer solchen abstrakten Realität einführen muss, um sie dem menschlichen Verstand und dem menschlichen Empfinden näher zu bringen. (Psychologisch gesprochen, hat diese dem Bewusstsein des Menschen angenäherte Form dieser Wirklichkeit *Sohn*-character). Diese ist bei Plotin der *Nous* (christlich: der *Sohn* Gottes) bei Meister Eckhardt die Gottheit, bei Jung die "Bilder des Unbewussten", in denen sich die an sich abstrakten und unanschaulichen Archetypen, deren höchstes das "Selbst" ist, manifestieren. Diese Figuren des Unbewussten sind in der Tat *persönlich*, (im Gegensatz zur "letzten Realität") in Indien der persönliche "Ishiwara" - und ich sehe nicht, wieso ausser diesen Figuren des Unbewussten noch etwas anderes persönlich sein kann.

Über die Art dieser dem Bewusstsein des Menschen angenäherten psychischen Wirklichkeit besteht die Meinungsverschiedenheit der Quaternären contra Platoniker (im weitesten Sinne), und hier muss ich die Platoniker (im Einklang mit Fludd und anderen) kritisieren.

(2) Dementsprechend steht im Taoteking, Nr. 5: "Nicht Liebe nach Menschenart hat die Natur: Ihr sind die Geschöpfe wie stroherne Hunde". Nach dem Opfer werden diese fortgeworfen.

3. Der Begriff 'privatio' (στέρησις) in der antiken Naturphilosophie. Die Materie und das Böse. Kritik des Neuplatonismus.

Um diesen Brief nicht allzu lange zu machen, will ich nur kurz diese geistesgeschichtlichen Fragen berühren. Ich kam auf diese Fragen, weil im Kap.V des Buches "Aion" von C.G.Jung **alles** weggelassen ist, was mir an der Idee der 'privatio' wichtig und interessant ist. (Offenbar ist es ihm unwichtig und uninteressant.) Es wird dort der Anschein erweckt, als sei die 'privatio boni' eine frühchristliche Erfindung (Plotin wird in grotesker Weise in diesem Zusammenhang dort gar nicht erwähnt!), während das

Gegenteil wahr ist, dass der Begriff *privatio* sehr alt und die Doktrin der *privatio boni* im späteren Platonismus organisch entstanden ist. - Aber wunderbarer Weise gelange ich von meinem anderen Ausgangspunkt aus zum gleichen Schluss wie Jung, dass nämlich die Idee der *privatio* abzulehnen sei. (Da ist eben bei Fludd, bei Jung und bei mir, wie bei vielen Anderen, der Archetypus der *Quaternität* dahinter!)

Der Begriff *privatio* (=στέρησις), deutsch 'Ermangelung' (was nicht gerade schön ist), spielt eine wichtige Rolle bei Aristoteles. Er polemisiert gegen eine schon vorhandene Ansicht der Eleaten, dass die *Materie* eine bloße *privatio der Ideen* sei. Sein Ausweg ist, dass die *Materie* zwar *actu* "nicht seiend" (νῆ ὄν), *potentia* aber "seiend" sei und nicht eine bloße *privatio*. "Nicht seiend" bedeutend damals (ich glaube seit *Parmenides*) immer etwas, was sich der begrifflichen Erfassung entzieht, worüber man "nicht denken" kann. Es bedeutet *nie*, dass etwas schlechthin nicht vorhanden sei. Z.B. sind die Phänomene "nicht seiend", alle Veränderung ist "nicht seiend", nur das Unveränderliche ist "seiend" (*Parmenides contra Heraklit*). Aristoteles hat die Entdeckung gemacht, dass man auch über *das* denken kann, was aus seiner Sache *wird*; es war ein Fortschritt, er kam von der Biologie her. Daher auch sein Ausweg der Unterscheidung 'actu' und 'potentia'.

Plato dagegen kam von der *Geometrie* her. Die geometrischen Ideen waren "seiend". Die empirischen Körper bestehen aus diesen Ideen plus dem X, was die wirklichen Körper von den Ideen unterscheidet und was Plato als rein *passivo*, "Aufnehmerin", "Amme" für die Ideen bezeichnet. Über dieses X konnte weiter nicht "gedacht" werden. Erst Aristoteles hat das X *Hyle* genannt.

Wahrscheinlich hat sich die Auffassung, dass die *Hyle* (später 'materia') nur eine Steresis (*privatio*) der Ideen sei, schon in der älteren platonischen Akademie (im Anschluss an die Eleaten) durchgesetzt, bei *Plato* kommt das Wort 'privatio' allerdings *nicht* vor.

Nun herrschte seit Sokrates eine *rationalistische Auffassung des Guten* (Lehrbarkeit der Tugend etc.). Das Gute allein konnte begrifflich erfasst werden, der gute Theos ist die "eine" *Idee*, aus der alle anderen Ideen, insbesondere die geometrischen hervorgingen. In der euklidischen Geometrie erkannte man auch den guten Theos. Dieser war nicht das Einzige, was vorhanden war, aber das Einzige, worüber "gedacht werden kann".

Im späteren Platonismus wurde daher mehr und mehr die Hyle mit dem Hässlichen und dem Bösen identifiziert³. Auch über das Böse konnte nicht gedacht werden, es war "nicht seiend" - wir sagen dafür 'irrational' -, nur das Gute war seiend. Daher gilt im Neuplatonismus

*Das Böse = Materie (Hyle), ist 'nicht seiend',
ist nur eine privatio des Guten (der 'Idee')*

Das ist zugleich eine naturphilosophische **und** eine theologisch-ethische Doktrin. Die eine ist unmöglich ohne die andere. *Glaubt man nicht, dass die Materie eine blosse privatio der Ideen ist, so wird es ganz sinnlos davon zu reden, dass das Böse nur eine privatio des Guten sei.*

Die Doktrin ist bei Plotin systematisch dargestellt und entwickelt (ist aber schon älter) und wurde von Augustin wie von allen Frühchristen mit griechischer Bildung *en bloc* übernommen. Statt das Eine (τὸ ἓν) sagte man 'Gott', und da bei Plotin (τὸ ἓν) und (τὸ ἄγαθόν) (das Gute) ausdrücklich 'ein und dasselbe' wird (das 'hyperagathon' steht in anderen Abhandlungen des Plotin, er scheint mir da *inkonsequent!*), so war Gott 'gut'.

Ich kann diese neuplatonische Doktrin nur so verstehen, dass das Gute das Rationale sei, das Böse das Irrationale.

Aber das Ganze, ein sehr *vergrößerter* Plato, ist überaus schwach begründet. Nicht nur glauben wir heute nicht mehr, dass wissenschaftliche Erkenntnisse bezw. das Rationale 'nur gut' seien (siehe die Anwendungen der Atomphysik), sondern auch schon in der Spätantike standen dem Neuplatonismus bereits andere konkurrierende philosophische Richtungen gegenüber. Da war ja alles Materialisierende wie die Atomistiker, Epikur und die Stoa, die ausdrücklich lehrten, dass die Materie hinsichtlich gut und böse ganz indifferent sei, da war die peripatetische Tradition, die auf dem bereits erwähnten Aristoteles fusst, da waren auch die Alchemisten mit dem 'Hermes Trismegistos', die sowohl an Aristoteles als auch an Platos 'Timaeus' anknüpfen⁴. Alle diese anderen philosophischen Richtungen der Spätantike verwenden den Begriff 'privatio' gar nicht. Und die Alchemisten sagten, dass die Materie nicht nur real sei, sondern dass in ihr "ein Geist wohne".

So kann auch Fludd auf eine lange Tradition zurückblicken (seine Terminologie ist stark aristotelisch) und die "trompetenden" Esel scheinen wohl fundiert!

(3) Der Philologe *H. R. Schwyzer*, der den Plotin neu herausgibt, war so freundlich, mir darüber einige Hinweise zu geben.

(4) Da war auch die mächtige *gnostische* Opposition gegen Plotins Doktrin des Bösen, von der er immer wieder spricht (wogegen er *nie* die Christen erwähnt)!

4. Schlussbemerkungen über den dissoziativen Charakter der geistigen Situation des 17. Jahrh. und über More-Bathynous' Traum.

Ich sehe nun etwas klarer, wie das Missverständnis des 'Lammschwänzchens' im Gottesbild allmählich entstand - diese geistesgeschichtliche Entwicklung sieht wie eine biologische Evolution nach Darwin aus - und wie sich More-Bathynous verzweifelt mit seinem Bewusstsein an dieses Lammschwänzchen angeklammert hat. Das Problem weist einerseits zurück bis ins alte Testament, andererseits vorwärts zu einem 'West-Ostproblem', von dem das 17. Jahrhundert noch nichts ahnte (erst 1801 druckte Duperron eine lateinische Übersetzung der Upanischaden in der Pariser Akademie) und aus dem auch Schopenhauer hervorging. Es ist aber für mich (wie für Fludd und Jung) kein Zweifel, dass nur die lammschwänzchenfreie Mutante des Gottes**bildes** eine Chance hat, im Kampf ums geistige Dasein zu überleben.

Im 17. Jahrh. war Fludd archaisch, unoriginell, ein Petrifakt und der Schein war gegen ihn. Die Lage war dissoziativ, wie sich in Boehmes Bildern und in Descartes' Philosophie zeigt. Was bei Desc. die Spaltung in Ausdehnung und Denken, das ist in More's Traum *die Spaltung von 12 in 2 x 6*. Diese Spaltung macht die Quaternität unmöglich. Die natürliche *Teilung von 12 wäre die in 3 x 4* gewesen, die auch der alten Teilung des Tierkreises entspricht (von der Fludd auch immer spricht).

Aber die Zeit war nicht reif für ein quaternäres Weltbild und die dunkle Hälfte fiel ins Unbewusste zurück. Erst wir beginnen unter der blauen Deckfarbe wieder Züge einer Schrift zu lesen, die uns Fludds Denkweise wieder näher bringt, gemäss der nur in der *mittleren* Sphäre das "*Sonnenkind*" entstehen kann!

PLC 0092.120

The above letter contains many details which have already been mentioned previously. However, it forms a unified whole which sheds light upon Pauli's thought in a significant fashion and also illuminates his working procedure in questions of history of philosophy. Clarification of the origin of the concept "privatio boni" is a good example in this regard.

Quarternity (a quaternarian picture of the world) will be dealt with in the following chapter. As a preliminary remark we may state that it replaces the trinitarian idea of three foundational principles with that of four. In regard to the picture of God it contains the concept that God also has an evil side; He is also a God of destruction. Evil is also a basic feature of existence, if one tries to describe it with the aid of human concepts. Evil, too, has its origin in God, who is the basis of the whole of existence.

The quaternarian way of thought rejects the Platonian conception of reality, according to which "the truly existing" is attainable through rational and logical thought. Irrationality is an essential constituent in the nature of reality.

In the beginning and the conclusion of the letter Pauli refers to the dream of More/Bathynous. At question is a tale of Henry More's book "Divine Dialogues", part III. Because it gives background for these problematics it is appropriate here to borrow a fragment from the dialogue in question. This tale is included in full in Fierz's article (1954) "Über den Ursprung und die Bedeutung der Lehre Isaacs Newtons vom absoluten Raum" (On the Origin and Importance of the Doctrine of Absolute Space by Isaac Newton). The letter just quoted is from the period of time when Fierz worked on this article.

Henry More: The Dream of Bathynous

The tale of Bathynous' dream is preceded by a rather lengthy discussion in which Philotheus and Hylobares take principal roles. They encounter difficulties in wrestling over the question of how God's goodness could be reconciled with all the evil which is found in the world, including the terrible sufferings of hell.

Bathynous is used as the representative of More's own thought. The discussion involves a number of people, the most dignified of which was Philopolis. The outcome of the opening discourse was that Bathynous consented to telling about a dream he had when young, which was beforehand known to Philotheus and was described by him as a general remedy against doubts concerning God's goodness and providence.

Bathynous: Gut denn, wenn es sein muss, meine Herren, mit der Erlaubnis von Philopolis und der Ermunterung von Hylobares

werde ich euch meinen Traum so kurz und gut wie möglich berichten. Zuerst aber musst du, Philopolis, wissen, was für ein grüblerischer und gedankvoller Geist ich von Kindheit an war und welch tiefes und starkes Gefühl der Existenz Gottes mich erfüllte und wie ich früh schon voller Bewusstsein ihm mich anvertraute. Und wie, da ich in reiferen Jahren zu denken begann, und einiges wenige von Philosophie eingesogen hatte, ich nicht damit zufrieden war, mir Gott nur in grossen Zügen zu denken. Vielmehr begann ich seine Natur schärfer und genauer zu betrachten und sann über seine Attribute nach und verglich sie. So schloss ich vertrauensvoll, teils aus natürlicher Neigung meines Denkens, teils auf Grund der Aussage und Autorität der Heiligen Schrift, dass unendliche Macht, Weisheit und Güte, diese drei, die wichtigsten und begreiflichsten Attribute der göttlichen Natur seien und dass die Güte die herrlichste unter ihnen sei, Krone und Blüte der Gottheit, wenn man so sagen darf, und dass durch sie vor allem der Menschen Seelen göttlich werden. Ohne sie aber würde auch der grösste Anteil an den anderen sie nicht göttlich, sondern teuflisch machen.

Da ich im übrigen keine andere Naturwissenschaft noch Metaphysik kannte als die des Volkes und da ich hoffte, dass die Gesetze der äusseren Schöpfung, sei sie sichtbar oder unsichtbar, jener herrlichen und lieblichen Idee der Gottheit entsprechen sollten, einer Idee, die ich mit der grössten Frömmigkeit und Herzlichkeit in meinem Busen hegte, so war mein Sinn lange Zeit mit unlösbaren Rätseln und Schwierigkeiten belastet, wie denn die Erscheinungen in der Welt und die volkstümlichen Ansichten mit jenen zwei höchsten Attributen der Gottheit, Weisheit und Güte, zu versöhnen und zu vereinigen seien. Unter solchen Meditationen schloss ich nachts meine Augen, sie grüssten mein Gedenken als erste am Morgen: sie begleiteten meine abgeschiedenen und einsamen Wanderungen durch Feld und Wald, oft so früh, dass dann die meisten andern Sterblichen noch im Bette liegen.

Es geschah daher, Philopolis, dass ich eines Sommermorgens, da ich früher aufgestanden war als gewöhnlich und so lange in einem gewissen Wald (den ich schon länger oft besuchte) gewandert war, dass ich es gut fand, mich am Boden auszuruhen. Da meine Lebensgeister erschöpft waren, teils zufolge der langandauernden körperlichen Bewegung, hauptsächlich aber wegen Schlafmangels und übereifrigen und angespannten Nachdenkens über solche Schwierigkeiten, wie sie Hylobares

entweder schon beschrieben hat oder die er, worauf ich schon hinwies, wahrscheinlich noch vorbringen wird; so streckte ich gleich meine müden Glieder zwischen Gras und Blumen am Fusse einer weit ausgebreiteten, grünenden Eiche aus, allwo die sanfftfrische Morgenluft im Schatten um meine erhitzten Schläfen spielte. Mit unbeschreiblichem Wohlgefühl erfrischte ich Blut und Lebensgeister, da die fleissigen Bienen emsig um mich über den taufrischen Honigblumen summten. In dieses nahe Geräusch mischte sich gar melodisch das entfernte Singen fröhlicher Vögel, das aus allen Teilen des Waldes widerhallte. Du kannst dir leicht vorstellen, o Philopolis, wie da der ganze Zauber der Natur zusammenwirkte, dass meinen müden Leib bald tiefer Schlaf umfing. Aber meine Seele war doch immer noch wach und träumte offenbar höchst lebhaft, ich wandere noch immer in diesem einsamen Wald, in meinen Gedanken angespannter denn je mit jenen alten Schwierigkeiten der Vorsehung beschäftigt. Aber während ich in dieser grossen Anfechtung und geistiger Bedrängnis schwebte und, wie es oft auch im Wachen geschah, heftige und innige Seufzer und Anrufungen zu Gott sandte, erschien plötzlich in einiger Ferne ein sehr ernster und verehrungswürdiger Mann, der langsam auf mich zukam. Er war grösser als gewöhnlich. Er war in ein weites, seidenes Gewand purpurner Farbe gekleidet, ähnlich wie jene "indischen" Talare, die heute Mode sind; nur waren die Ärmel etwas länger und weiter. Dieses Gewand war mit einem priesterlichen Gürtel zusammengehalten, ebenfalls purpurfarben. Er trug ein Paar sammetene Pantoffeln der gleichen Farbe, aber auf dem Kopfe hatte er einen grossen, schwarzen Sammethut, so wie wenn er zugleich Reisender und Bewohner dieser Örtlichkeit wäre.

Cuphophron: Ich wage es, dir zu versichern, das war das Gespenst eines der edlen Ahnen jener vornehmen Familie, der diese Waldungen gehörte.

Hylobares: Du vergisst, Cuphophron, dass Bathynous einen Traum erzählt und dass - und dies zum dritten Male - Gespenster, also Geister, nirgendwo sind und man ihnen daher nicht im Walde begegnen kann.

Philopolis: Genug damit, Hylobares. Bitte, fahre fort, Bathynous, und beschreibe uns sein Alter und Aussehen, ebensogut wie seine Kleidung.

Cuphophron: Bitte, mache dass, Bathynous: ich höre Dinge wie diese gerne ganz genau berichtet.

Bathynous: Hätte nicht die Rötlichkeit seiner Haut und die

Lebhaftigkeit seines Blickes dagegen gesprochen, die schneeige Weisse seiner Haare, der grosse Bart und gewisse greisenhafte Züge seines Gesichtes hätten vermuten lassen, er sei etwa hundertzwanzig Jahre alt.

Sophron: Darin liegt ja kein Widerspruch, *Bathynous:* Denn von Moses wird gesagt, er sei hundertzwanzig gewesen, als er starb, doch war sein Auge nicht trübe noch seine Körperkraft geschwunden; doch, bitte, fahre fort.

Bathynous: Wie er noch entfernter war, stand ich furchtlos und unbewegt, nahm jedoch meinen Hut ab und behielt ihn in der Hand, aus Achtung vor einer so verehrungswürdigen Gestalt. Als er aber näher kam, da erfüllte mich der lebhaftige Glanz seiner Augen, die gar durchdringend unter dem Schatten seines schwarzen Hutes hervorblitzten, und sein ganzer Gesichtsausdruck, der doch voll wundervoller Milde und Süsse war, mit plötzlichem Schrecken, so dass ich furchtbar zu zittern begann und mich nicht mehr hätte aufrecht erhalten können, wenn er mir nicht seine Hand aufs Haupt gelegt und mir tröstlich zugesprochen hätte. Dies tat er väterlich und sprach: "Gott segne dich, mein Sohn, sei guten Muts und fürchte dich nicht; denn ich bin ein Bote Gottes, um deines Heils willen gesandt. Dein ernstes Mühn und Seufzen nach wahrer Erkenntnis deines Schöpfers und nach den Wegen seiner Vorsehung (dies ist die heilsamste Beschäftigung jedes denkenden Wesens) sind vor Gottes Angesicht emporgestiegen; ich habe den Auftrag, die beiden Schlüssel der Vorsehung in deine Hände zu legen, auf dass du mit ihrer Hilfe die Schatzkammern jener Weisheit aufschliessen mögest, die du so eifrig und fromm erstrebst." Hiemit führte er seine rechte Hand in den linken Ärmel und zog zwei hellglänzende Schlüssel hervor, einer von Silber, der andere von Gold, die durch ein gar schönes himmelblaues Band zusammengeknüpft waren, und legte sie in meine Hände. Ich empfing sie in tiefer Demut und voller Dank für ein so grosses Geschenk.

Während dieser Zeit hatte ich mehr als gewöhnliche Kraft und Mut erlangt, was, wie ich bemerkte, mir in wunderbarer Weise durch seine auf mein Haupt gelegte Hand vermittelt worden war, so dass ich eine Art freier Sicherheit und Vertrautheit, mich mit ihm zu unterhalten, erlangte. Darum sagte ich zu ihm, wenn auch mit gebührender Höflichkeit, doch ohne alle Furcht: "Dies ist ein köstliches Paar Schlüssel, mein Vater, und sehr lieblich anzusehen: Aber wo ist der Schatz, den sie erschliessen sollen?"

Darauf antwortete er, mich anlächelnd, sogleich: "Die Schätze, mein Sohn, sind in den Schlüsseln selber." "Dann bedarf ein jeder Schlüssel", sagte ich, "Vater, eines zweiten Schlüssels, ihn aufzuschliessen." "Jeder Schlüssel" sagte er, "mein Sohn, ist sein eigener Schlüssel." Und damit forderte er mich auf, die Buchstaben zu betrachten, die auf dem silbernen Schlüssel eingeprägt waren, und ein gleiches Kunstwerk war auf dem goldenen zu sehen. Da ich sie nun näher ansah, bemerkte ich, dass die Schlüssel aus einer Gruppe eng aneinander schliessender Ringe bestanden und dass die ganzen Schlüssel ganz unregelmässig und verwirrend mit Buchstaben bedeckt waren.

"Bring die Buchstaben der Schlüssel in die richtige Ordnung", sagte er nun, "und ziehe dann an ihren Griffen, und der Schatz wird herauskommen." Und ich ergriff den Silberschlüssel; aber obwohl ich die Ringe bewegen konnte, indem ich mit meinen Fingernägeln in die Buchstaben griff, so konnte ich die Buchstaben doch in keine Ordnung bringen, in der sie alle auf geraden Linien gestanden hätten, noch ergab sich irgendein Sinn in irgendeiner Linie. Wie dies der alte Mann sah, sagte er: "Du musst erst das Motto kennen, mein Sohn, dieses ist der Schlüssel der Schlüssel." "Ich bitte dich", sagte ich, "o mein Vater, teile mir das Motto mit." "Das Motto", sprach er, "mein Sohn, ist dies: *Claude fenestras, ut luceat domus.*" Da ich nun das Motto kannte, versuchte ich aufs neue, und indem ich die dem Motto entsprechenden Buchstaben in eine Linie gebracht hatte, zog ich mit meiner Rechten am Griff, indem ich den unteren Teil in der Linken hielt. Und da kam eine silberne Röhre zum Vorschein, in der eine Rolle war, die meiner Meinung nach aus dünnem Papier bestand, die aber so stark wie jedes Pergament und weiss wie neuer Schnee war.

Diese Rolle nun erkühnte ich mich zu öffnen. Sie war völlig quadratisch, auf allen Seiten mit gleichbreitem Rand, der mit Linien in himmelblauer Farbe ausgezogen war, höchst vollkommen und lieblich. In der Mitte war das Bild der Sonne in blendendem Gold! Um die Sonne waren sechs Kreise mit ebenso blauen Linien gezogen. Zwei dieser Kreise waren sehr nahe beim Sonnenkörper, die vier anderen waren von ihm und untereinander weiter entfernt. Auf jedem dieser Kreise war ein kleiner Fleck, wie eine Kugel, aber in zwei verschiedenen Farben; die eine Seite gegen die Sonne glänzend wie Silber, die andere von trübem, missfarbenem Schwarz. Um die kleinen Kugeln im dritten und fünften Kreis waren kleine blaue Kreise gezeichnet, einer um die

dritte und vier um die fünfte: und auf jedem dieser Kreise war wieder ein kleiner, kugelartiger Fleck, von kleinerer Grösse als der in der Mitte. Es war auch etwas um die Kugel auf dem sechsten Kreis, aber daran erinnere ich mich nicht mehr so genau. Ausserhalb dieser Kreise war eine unzählbare Schar sternartiger, goldener Figuren, von ähnlichem Glanze wie der der Sonne, aber weniger stark, die, zufällig verstreut, teils entfernt vom Rand, teils nahe bei diesem, teils von diesem durchschnitten waren, so, als ob angedeutet werden sollte, dass ihrer noch viel mehr seien bis zu unbestimmten Fernen. Dieser Plan unterhielt meine staunenden Augen eine gute Weile; denn dergleichen hatte ich noch nie gesehen, und ich war entschlossen, seine Linien fest in mein Gedächtnis zu prägen, damit ich mich später mit jenem verehrungswürdigen Manne desto leichter darüber unterhalten könne. Denn ich kannte den Sinn der Zeichnung der Inschrift am oberen Rande wegen, die lautete: "Das wahre Weltsystem". Indem ich mich so befriedigt hatte, rollte ich die Rolle wieder auf, versorgte sie in der silbernen Röhre und schob diese ohne Mühe in den unteren Teil des Schlüssels. Und indem ich die Linie von Buchstaben, die das Motto enthielt, wieder verstellte, war alles sicher wie vorher abgeschlossen.

Nachdem mich die Eröffnung des ersten Schatzes so gefreut hatte, war ich desto begieriger, auch den zweiten zu gewinnen; und da ich wusste, dass jeder Versuch umsonst wäre ohne die Kenntnis des Mottos oder "des Schlüssels des Schlüssels", so ersuchte ich diesen göttlichen Weisen, es mir mitzuteilen. "Das werde ich gerne tun, mein Sohn", sprach er: "und ich bitte dich, nimm es wohl in acht. Es lautet: *Amor Dei Lux Animae*." "In der Tat: ein herrliches Motto", sagte ich. "Dieses Motto ist an sich selber ein Schatz." Doch machte ich mich ans Werk wie zuvor, und indem ich die Buchstaben so ordnete, dass eine ihrer Linien das Motto klar enthielt, zog ich an beiden Enden des goldenen Schlüssels, so wie ich es am silbernen getan hatte, und in einer goldenen Röhre, die im Griff des Schlüssels eingelassen war, fand ich eine Rolle aus feinem Papier, wie man es nennen kann, sehr weiss und rein, das, obwohl sehr dünn, durchaus nicht durchscheinend war. Die Beschriftung war wieder auf allen Seiten von einem gleichmässigen Rand begrenzt. Nur war dieser viel prächtiger, reich geziert mit Blumengewinden in Gold, Karmin und Blau. Und ich sah dass zwölf in goldenen Buchstaben geschriebene Sätze die ganze Fläche füllten. Der erste Satz war:

Das Mass der Vorsehung ist die göttliche Güte, die nur in sich selber beschränkt und unendlich ist.

2. Der Faden der Zeit und die Ausdehnung des Universums: die gleiche Hand hat jenen gesponnen und breitete diese aus.

3. Dunkelheit und Abgrund waren vor dem Licht und Sonnen oder Sterne vor jeder Undurchsichtigkeit oder jedem Schatten.

4. Alle denkenden Geister, die je waren, sind oder sein werden, entsprangen mit dem Licht und jubelten vor Gott im Schöpfungsmorgen.

5. Angesichts der unzählbaren Scharen freier Wesen, Gestalter ihres eigenen Schicksals, wäre es ein Wunder gewesen, wenn alle denselben Weg beschritten hätten. Und darum reichten sich schliesslich Sünde und Undurchsichtigkeit die Hände.

6. So wie das Licht den Schatten übertrifft, so übertreffen auch die Gegenden des Glücks jene von Sünden und Elend.

Diese sechs, Philopolis, erinnere ich genau, aber ich hatte alle zwölf mit meinen Augen überflogen. Doch nachher ging ich sie der Reihe nach genau durch, um sie alle genau in mein Gedächtnis einzuprägen (denn ich erwartete nicht, dass ich die Schlüssel mit nach Hause nehmen dürfe), und wie ich bis zum sechsten Aphorismus gelangt war, waren zwei Esel hinter mir aus dem Wald gekommen, einer auf der einen, der andere auf der anderen Seite des Baumes, und diese begannen so laut und roh zu schreien, dass sie mich nicht nur weckten, sondern mir überdies in grausamer Art klarmachten, dass ich die ganze Zeit nur geträumt hatte. Denn jener alte, ernste Mann, die silbernen und goldenen Schlüssel und herrlichen Pergamente, alle verschwanden plötzlich, und ich fand mich am Fusse jener Eiche sitzend, unter der ich eingeschlafen war, zwischen zwei roh schreienden Eseln.

Euistor: Das ist die gewöhnliche Erfahrung, *Bathynous*, die man mit diesen Tieren macht. So geschah es der Nymphe *Lotis*, die in einer Mondscheinnacht fest im Grase schlief und durch das laute Brüllen von *Silens* Esel geweckt wurde. Esel scheinen die Trompeter der Wälder zu sein, *Bathynous*, die sorglose Menschen aus tiefem Schlafe wecken*.

*This text is taken from M. Fierz's article mentioned on pg. 41.

The Darker Side of God

The problem of evil is closely interrelated to our God-image. Looking upon God only as a loving father to whom we can turn when life gets difficult, can become a stumbling block for many sincere seekers of truth. How then can God permit the innocent believer to suffer and the selfish one to succeed? Why did He create the world in such a way as to contain so much suffering? In place of love we see selfishness ruling the world; in place of good, evil.

Theological explanations sound like mere phrases to an individual who must experience personally the power of selfishness and evil. Such explanations are coloured by the suppression of irrationality and evil in Western culture. This is a powerful culture which has increased its material prosperity in staggering proportions. We have nevertheless still not seen where this road leads. The intellectual search for truth has led to the harnessing of the powers of nature for man's purposes. The fact that the other sides of human spiritual life have remained undeveloped, as compared to the intellect, is a dangerous thing. The search for truth is intimately intertwined with the struggle for power, and more and more people are beginning to feel that this road leads in the end to destruction.

From its inception, Christian theology has contained a feature which Pauli called a "lamb's tail"--the one-sided emphasis on God's love and care. One does not face the problem of evil in all its awfulness and devoid of all reason. Does not the "bellow of the donkeys" prevent us from seeing the facts which are not rational and good, but rather, in which the irrationality and evil aspects of reality are displayed? God has His darker side--He also destroys.

Pauli dealt with such problems very seriously; his God-image was perhaps closer to the Yahweh of the Old Testament than that of a caring and loving father. We will examine this more closely in the next chapter.

Biologists should be at an advantage for understanding Pauli's quaternarian thought. They, after all, see the sufferings and death which are a presupposition for the birth of anything new. Organic nature is full of the irrational and evil. It can help us to understand--or perhaps even if not to understand, to nevertheless accept the fact that it is in suffering and in the incomprehensible that we find the key to evolution.

Unfortunately, most biologists refuse to deal with these questions. They are "unscientific" and a real scientist should not consider them. That of, for example, the origin of the purposefulness that is seen so clearly everywhere in organic nature. "Pure chance" and "necessity" (causality) are the slogans which a biologist throws out when he is asked what the directing force

behind evolution is. They will explain everything...if not today then at latest tomorrow or the day after.

But what if the key to the matter lies in what chance is concealing?

A Certain Dream

Pauli understood very well what kind of opposition was to be expected if such changes would occur which he considered to be exigent for a healthy development of Western culture. Perhaps the "repression" which Pauli saw in certain dreams of his was due to anticipations of just such difficulties. This series of dreams also included a significant one which Pauli had in the spring of 1954. It set off an interesting discussion in the exchange of letters between Pauli and Fierz but this must be omitted here. Let us simply relate the dream in question as told by Pauli in an appendix to a letter sent to Fierz. For the sake of clarity, however, let me first state that in Pauli's thought Kepler was a typical representative of the trinitarian conception of reality. Also, Regiomontanus (alias Johannes Müller) who appeared in the dream was at first put into the same category in the correspondence but later on the picture of him changed.

April 18, 1954 (After returning from the U.S.)

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Habe vorher den Aufsatz von Fierz zum ersten Mal gelesen.
(Am 11. April kam ich in Zürich an.)

18. April

Traum. Ich sehe einen *englischen* Text vor mir. (An dessen Worte konnte ich mich beim Aufwachen nicht mehr erinnern.) Unterhalb dieses Textes sind aber andere Worte, auf die von besonderen Pfeilen auf dem Papier hingedeutet wird. (Diese Pfeile sollten wohl meine Aufmerksamkeit von dem englischen Text *weg* auf jenen zweiten Text lenken.) Diese anderen Worte erscheinen mir als "geheim". Sie lauten:

"Die Sonne wird sich heute als ebenso wirksam erweisen wie zur Zeit Keplers."

Nun steht neben mir ein überlegener Mann, ein "alter Weiser", ein "Meister". Ich frage ihn, ob diese geheimen Worte von *Newton* sind. Aber der Meister antwortet mir mit klarer fester Stimme:

"Sie sind vom Kanzler Regiomontanus!"

Dann erwache ich. (NB. Unter "Kanzler" verstand ich jedenfalls einen Regierungsbeamten.)

Beim Erwachen fällt mir zu Regiomontanus sogleich jener *Müller von Königsberg* ein. Er war wohl zeitlich nahe an Newton. Ich müsste aber wohl nachsehen, was er geschrieben hat. Im Traum kommen bei mir häufig jene sogenannten "Kryptomnesien" vor.

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Pauli's memory of Regiomontanus was hazy, for he lived already in the 15th century, thus, a couple of hundred years before Newton. "His words" are perhaps an expression of Pauli's fears that the irrational and evil would remain suppressed in the depths of the unconscious, just as in the 17th century. Or is this type of dream analysis perhaps too straight forward? (Much more exciting details appeared in Pauli's letters in which he struggled to find out what Regiomontanus wanted to reveal to him.)



The quaternity of the cross in the zodiac, surrounded by the six planets.
Jacob Böhme's book *Signatura rerum*, (1682).
(By courtesy of the Helsinki University Library)

Quaternity

The Number Four and Reality

Bei Ihm, der einpflanzte die Vierzahl unserem Geiste, sie, die Quelle und 221
Wurzel der ewig strömenden Schöpfung.

Schopenhauer chose this Pythagorean oath as a motto for his important publication, "Über die vierfache Wurzel des Satzes vom zureichenden Grunde" (The Fourfold Root of the Principle of Sufficient Reason). The basic idea of the Pythagorean numerical mysticism was that of *comprehending reality on the basis of harmonies, i.e.,* with the aid of relations between integers. These harmonies appeared on the one hand in cosmology, in the construction principles of the heavenly spheres, and on the other hand in earthly affairs, *e.g.,* in relations regulating the basic order of life.

The *number four* stood for *justice*. For this reason it was the kernel of the oath. But it also had a wider significance. Its geometrical analogue was the *tetrahedron*, which was the simplest of all the polyhedrons. It, therefore, implied *three-dimensionality*, which the integers smaller than four did not presuppose. Thus the number four *was a symbol of the union of heaven and earth*. It was therefore important for an understanding of reality. The figure:

```

      x
    x  x
  x  x  x
x  x  x  x

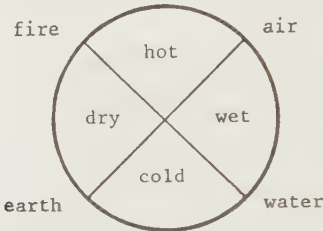
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was called the *tetraktys*: it showed that the number ten which represented a whole is created out of the four smallest integers:

$$10 = 1 + 2 + 3 + 4$$

The mystical significance of the number four was also expressed in the ancient doctrine of the four elements, which Empedocles introduced into

Greek philosophy. Matter in the sublunary world was thought to consist of earth, water, air and fire. The superlunary world was filled with a "fifth element", ether, which was not really matter in the ordinary sense of the word: it could not be detected by the senses. The four ordinary elements were formed from ether as a result of the *separation of opposites*. There were two basic pairs of opposites: hot-cold and wet-dry. Earth was a cold and dry substance, water cold and wet, air hot and wet, fire hot and dry. These were the four basic forms of matter which could, however, be combined in different ways with one another, as well as be converted into one another.



The number four was associated with creation and change in the sense that the terrestrial world, which consisted of the four basic elements, was subject to change. There were no changes in the superlunary world aside from uniform circular motion in which the path remained invariant when rotating around its center.

The Aristotelian conception of reality subscribed to this doctrine of the four elements. *Aristotelian logic* was also associated with the number four in a peculiar way. If in the adjoining figure we replace the words "hot" by "general", "cold" by "partial", "dry" by "affirmation" and "wet" by "negation", we get four basic forms of assertion in place of the elements: "general affirmation" (in place of "fire"), "general negation" (in place of "air"), "partial affirmation" (instead of "earth") and "partial negation" (in place of "water"). (A similar structure is also found in Aristotelian modal logic.)

This subsequently implied the appearance of the number four in *the table of categories of Kant*--as is well known, Kant based his philosophy on Aristotelian logic. Kant's categories can be grouped into four basic classes in the following manner:

I. Quantity					
	Unity	Plurality	Totality		
II. Quality			III. Relation		
Reality	Negation	Limitation	Substance	Causality	
			Community		
IV. Modality					
Possibility	Existence	Necessity			

Classes I and II deal with observation: I regards pure observation and II empirical observation. Kant referred to these as mathematical categories. Classes III and IV concern the existence of beings: III the relations of beings to one another and IV the relation of beings to mind. Kant called these dynamic categories.

Fierz preferred to refer to classes I and III as mathematical, II and IV as empirical.

In any case, we are also dealing here with an outline of reality on the basis of four fundamental types. Fierz noted that the same thing is to be found in a quantum mechanical conception of reality. It involves, if we accept the idea of complementarity, two fundamental types of opposites:

1. *polar opposites*, which can be described in terms of positive and negative quantities, and

2. *complementary opposites*, which are "mutually exclusive" in the same sense as a particle's position and momentum.

Polar opposites can also be termed (+,-)-opposites, complementary opposites (p,q)-opposites. (In mechanics q is the usual symbol for the positional coordinate and p for the momentum coordinate.)

The *trinitarian* thought characteristic of traditional natural science can be described as allowing only the (+,-)-opposites. Quantum mechanics, however, has had to employ opposites which do not completely exclude one another, but rather, are of such a nature that an increasingly exact determination of a given property makes the "complementary" property more and more inexact. In this way one can speak of *two separate types of opposites*, thereby coming upon the idea of *quaternity*. Pauli was inclined to agree with the characterization of the idea of quaternity in this way, as Fierz has proposed.

Kant did not know of complementary opposites and for this reason he only came halfway in his attempts at outlining a quaternarian conception of reality. In any case, the seed of the quaternarian attitude can be seen in his table of categories.

Quaternity appears in even clearer form in Schopenhauer's thought. The only one of Kant's categories which he preserves is that of causality; instead, he presents *four roots for the idea of sufficient reason*:

1. causal reasons
2. logical reasons
3. reasons of existence
4. motives

"Reasons of existence" is perhaps a bit of a strange name for the purely logical relations concerning space and time, which according to

Schopenhauer form the origin of geometry and arithmetic. At any rate there are thus four "roots", just as there are four classes of Kant's categories. In addition, Kant and Schopenhauer share a *deterministic view of the concept of causality*: sufficient reasons for empirical events presuppose that nothing happens without cause. In just this regard quantum mechanics has brought about a fundamental change.

In Schopenhauer's scheme, reasons 2 and 3 are of a logico-mathematical nature, reasons 1 and 4 empirical. The causal reasons relate to the events of the material, external world, motives to the events of the spiritual, internal world. Because the causality of the physical world was assumed to be absolute, a man's free will cannot mean a possibility of choices which could alter the causal chain of events in the physical world. Schopenhauer writes, "In fact, our deeds are never truly the very beginning of something and therefore they do not bring about anything essentially new, but rather, we merely experience what we are through what we do". The events of the spiritual world, thus, are regulated by the motives and the freedom of the will means only that we experience something which is actually determined by motives. We cannot create anything truly new.

If we enlarge the scheme of Schopenhauer with the idea that empirical reasons 1 and 4 are complementary to one another and that both in the physical world as well as in the spiritual world causality is by its nature statistical and not absolute, we are then led to the concept of quaternarity in the sense in which Pauli and Fierz have spoken of. In this way the "regularities" of the physical and spiritual world are related to one another, and the problem of the freedom of the will can be examined from quite a new perspective: the concept of statistical causality can be applied to both the "causes" of the phenomenal world and to the "motives" of the spiritual world. The world of matter and the world of the spirit melt in this way into a unified whole.

A Letter

Perhaps the most central theme of the correspondence between Pauli and Fierz was the discussion of a *quaternarian conception of reality*. Their description of, on the one hand, the trinitarian and, on the other hand, the quaternarian conceptions revealed a deep difference in attitudes between the researchers, a difference which often motivated a sharp exchange of opinion. The direction of the struggle is quite different for the representatives of the conflicting opinions, and they did not seem to understand one another's arguments at all.

Pauli ran up against this kind of problem in his research on Kepler (1952), in which he described the afore-mentioned polemics between

Kepler and Fludd. Fierz, on the other hand, met up with the same sort of dilemmas in his previously mentioned research on Newton (1954). In struggling with these questions they were led to an exposure to the psychological concepts of *C.G. Jung*.

As a suitable background to this matter we may quote Pauli's letter to Fierz on October 3, 1951. If the details related to physics seem to be too difficult for the reader, it is no wonder, for even physicists may have to rack their brains over them. I nevertheless believe that the basic ideas are understandable.

Als ich begann mich mit Keplers Trinitätsbild zu beschäftigen, wusste ich noch nichts von der Fludd'schen Polemik und noch weniger, dass die Vierzahl für Fludd eine so wesentliche Symbolbedeutung hat (die betreffende längere Stelle wird in meiner Arbeit abgedruckt und übersetzt) - ich wusste nur, dass für Kepler die ihm wohl bekannte pythagoreische Tetraktys *keine* symbolische Bedeutung hatte. So bin ich diesmal auf der psychologischen Linie *wieder* auf das Problem des Überganges von 3 zu 4 gestossen. In beiden Fällen hat bestimmt nicht Herr C.G.Jung mir das suggeriert noch lag von vornherein eine bewusste Absicht vor, mich ausgerechnet mit dem Problem 3 und 4 auseinanderzusetzen. Deshalb bin ich ziemlich sicher, dass mit diesen Zahlen *objektiv* ein wichtiges psychologisches und vielleicht naturphilosophisches Problem verbunden ist.

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Dann zum Gegensatzproblem: in der Physik gibt es nun *kompensatorische Gegensatzpaare* (durch positive und negative Grössen dargestellt, wie die beiden elektrischen Ladungen) und *komplementäre Gegensatzpaare* (durch nicht vertauschbare Grössen dargestellt wie p und q). Das ist eine sehr wichtige Unterscheidung, denn es ist meine persönliche Ansicht, dass sie im Psychologischen ihr Gegenstück hat: Ein kompensatorisches Gegensatzpaar scheint mir - wie auch Ihnen - gut und böse, ein komplementäres Gegensatzpaar aber bewusst - unbewusst (im Chinesischen ist das Entsprechende: Yang und Yin). Nach meiner Ansicht krankt die analytische Psychologie noch sehr am Fehlen dieser Unterscheidung (was mit der ungenügenden mathematisch-naturwissenschaftlichen Bildung ihrer Vertreter zu tun hat). *Siehe unten*. Ich wäre sehr froh, wenn Sie ganz schulmeisterlich auf dieser begrifflichen Differenzierung in Ihrem Aufsatz insistieren würden. Diese Sache bringt mich nun auf eine andere, in Ihrem Aufsatz ebenfalls behandelte: Die prinzipiellen

Schwierigkeiten des Feldbegriffs. Sie haben die "Satzung" der *Realität* des Feldes sehr schön dargelegt auf p. 14: "Aber Faraday dachte, dass das Feld vorhanden sein müsse, ob wir es nachweisen oder nicht, genau so, wie wir glauben, der Mensch sei vorhanden, ob wir ihn anschauen oder nicht." Man kann noch hinzufügen: "genau so wie wir annehmen, dass die Bewegung des Mondes dieselbe sei, ob wir ihn anschauen oder nicht" (was über dessen blosses Vorhandensein noch sehr hinausgeht)¹. Das ist natürlich der ganze Pferdefuss, sowohl hinsichtlich der Physik (*quantisierte* Feldtheorie) als auch hinsichtlich der psychologischen Analogie.

Ich bin etwas anderer Ansicht als Sie, indem ich der Unmöglichkeit des leeren Raumes in der quantisierten Feldtheorie nicht dieselbe Bedeutung zuschreibe wie Sie. Nach meiner Meinung bleibt der Pferdefuss nämlich in der quantisierten Feldtheorie trotzdem *doch ganz derselbe* wie in der nicht quantisierten klassischen: Es sollte so sein, dass ein Feld ohne die zu dessen Messung nötigen Probekörper auch mathematisch-logisch nicht *denkbar* ist. In Wirklichkeit ist es aber in der jetzigen Theorie so: setzt man $e = 0$, beschreibt also Lichtfelder, so sind diese, seien es klassische Felder oder Photonen, *ohne* Ladungen mathematisch möglich; setzt man $e \neq 0$ und beschreibt Elektronen, Positronen und Photonen (Schwinger), so sind diese mathematisch möglich *ohne* die in den Messapparaten vorhandenen schweren Massen, die man braucht, um die Felder oder Ladungsdichten in kleinen Räumen (der Ordnung h/mc , m = Elektronmasse) auszumessen. Das wahre Komplementaritätsverhältnis zwischen der Möglichkeit, *dieselben* physikalischen Objekte entweder als Felder oder als Probekörper (Messapparate) aufzufassen (erstes dann, wenn *andere* Objekte als Messapparate fungieren) ist im jetzigen Formalismus nicht ausgedrückt. (NB Was nützt es mir, dass *kein* leerer Raum möglich ist?)

(1) Ich nenne das vielleicht "die klassizistische Idee der objektiven Realität im Kosmos".

PLC 0092.077

The Problem of "The Fourth"

The conflict between Kepler and Fludd was a matter of differences in attitude between different psychological types. Because of the strong position which the natural sciences and technology have attained during our

cultural development, the general tendency is to reject Fludd's view and consider Kepler as the representative of progress. The matter demands further deliberation, however, because many feel that natural science is guiding culture along too one-sided a path: the material and spiritual drawbacks brought about by the scientific-technical revolution are growing to unexpected proportions.

The question is basically that of what value we give to a *uniform description of the reality* in which we live. The development of science has led into ever greater specialization and as a result, the over-all view of reality has grown dim. The spiritual component of reality in particular has received increasingly less attention, and for this reason we are no longer able to analyze questions which deal with man's relationship to the world around him from an unbiased perspective.

Perhaps we can learn something from this by considering a time in which problems involving a uniform perspective were thought to be important and contemporary. This is a reason for returning to the polemics of Kepler and Fludd. Here we meet up with what is to us a strange language, archaic manners of thought and symbolic descriptions which modern man is not used to. But it seems that this is exactly what we need if we want to find once again a unified view and to learn on its basis how to judge cultural development in a well-balanced manner. Symbolic descriptions are a very effective manner of awakening an intuitive, wholistic perspective.

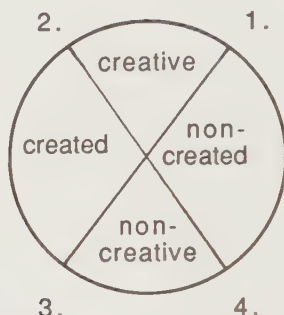
In connection with his research on Kepler, Pauli described two medieval currents of thought which represented trinitarian and quaternarian views, that is, the ways of thought of Kepler and of Fludd. He termed them *Platonic* and *alchemistic* (or hermetic). Both aimed at achieving a wholistic approach to the world, but in different ways.

The Platonic tradition was represented at that time by Neoplatonism, which has already been spoken of. According to it, the One, God, created the World of Ideas (Logos) through the emanation of his power, which in turn gave birth to the world soul and matter. Matter was the limit of the creation process, the point at which the creative force was completely exhausted. But Neoplatonism also involved the process of *anti-creation*, in which the world is reunited to its Creator. Creation is an on-going process in which God unceasingly upholds his world which is continuously reunited with the Creator. In this way a cyclical process is created and continues in the same fashion eternally.

Scotus Eriugena, the antischolastic philosopher who already in the 9th century presented ideas of Neoplatonism has described this cycle in the following manner: "Finis enim totius motus est principium sui; non enim alio fine terminatur nisi suo principio a quo incipit moveri." (The goal of all motion namely can be seen in its origin; namely, no other limits to it are to be seen than those of its origin, which creates motion.)

If a Platonist was asked what the meaning of this eternal cycle is, he responded: beauty. We must simply try to comprehend the eternal existence of this beauty and conform to that never-ceasing cyclical path.

Scotus Eriugena has also described that cycle with the aid of a figure containing two pairs of opposites: creative-noncreative, and created-noncreated. The figure is analogous to that characterizing the properties of the four elements; in place of the elements, though, there are four basic forms of existence:



1. *Natura creans nec creata* (creative and noncreated). This is God the Father, the beginning and end of the cycle.

2. *Natura creans creata* (creative and created). This is God the Son, through whom the world was created.

3. *Natura creata nec creans* (created and noncreative). This is the created world. Scotus Eriugena associates this with the Holy Spirit: through its mediation God exists in the world.

4. *Natura nec creata nec creans* (that which is neither created nor creative). Scotus Eriugena interprets this as the deification, that is, a return to God.

The fourth basic form of existence here is especially interesting: it is actually missing because it only means that one returns from the third stage to the first. We find here the trinitarian thought characteristic of the Platonian tradition: "the fourth" is missing--or is merely the same as the first.

The alchemist's view of the basic character of natural events differed to the extent that he felt *some outcome always originated from a change* which had not existed previously. The main aim of a chemical process was the creation of a philosopher's stone (*lapis*) which simultaneously involved a change in the psyche of the person in question: the "freeing" of his soul. This kind of process never returned to its original state, rather, somekind of permanent outcome was produced. For this reason an alchemist could not accept Scotus Eriugena's Platonian description of a cyclical process.

At this point I would like to make a few comments.

The alchemical view of the processes of nature corresponds to the thermodynamical processes which the heat machines are based on. They repeat the same cycle again and again but not everything returns to the original state at the conclusion of the cycle, rather, there is an irreversible *outcome*: a certain amount of heat is converted into mechanical work. These kinds of processes can, admittedly, be utilized in "creating" certain hoped-for outcomes.

The natural scientist has therefore cause to take the "fourth one" seriously, which according to Platonism simply means a return to the original state. Only "the fourth" involves the possibility of *creating something new*. It makes the world a world of continuous evolution which does not remain eternally the same, as the Platonist assumed.

The identification of the different stages of a Platonian cyclical process with the individual persons of the Trinity might be introduced by Scotus Eriugena. If we want on this basis to carry our symbolism still further, personifying also the fourth form of existence, then a natural interpretation would be to say that it represents Satan. Such an idea, however, is rather foreign to Christian theology. But if we accept what was referred to as the problem of evil in the previous chapter, then this kind of concept is no longer strange. The evil which Satan should personify has, after all, also originated with God. God is "He who makes the light and creates the darkness, who brings forth joy and creates sorrow". Actually, the fact that God is also a God of destruction is a prerequisite for the creation of something new. Luther, too, spoke of God's "left hand work" in addition to his right hand work. And the mystery of suffering is, after all, something quite central to the Christian faith.

Therefore it would hardly be deviating from the basic ideas of the Christian religion to associate forms 1 and 4 of existence in the model of Scotus Eriugena with the right-hand and left-hand work of God. In this way we open up the possibility for seeing the world as developing--God is a living God, continuously creating something new.

Where Leads the Road?

During Pauli's last years, his letters expressed a kind of weariness and uncertainty in regard to what is worth attempting. He was concerned that research in the field of physics was becoming increasingly marked by technical problems, without paying attention to those problems concerning the foundations of physics which Pauli considered of greatest importance. Nor has later development matched Pauli's hopes--more so his fears. Elementary particle theory has mainly developed on the basis of field

theory, but the sort of fundamental problems which made Pauli dissatisfied with the basis of field theory are still unsolved. The basic research of quantum mechanics has dealt with questions which Pauli considered to be efforts "in the wrong direction"; the "salvaging of realism" has been considered a matter of great importance in microphysics also, which means that the idea of the objectivity of the external world, *i.e.*, the idea of a "detached observer", has been generally accepted. This means a cancellation of that which Pauli considered to be the most important philosophical gift of quantum mechanics. Great attention is focused on cosmological theories and in this regard questions which are traditionally associated with the religious perspective are investigated in the spirit of purely "trinitarian thought". Biologists have similar attitudes in their field. The clear distinction between religion and science has in the United States--in lawsuits regarding creationism--been made an official doctrine, on the basis of which the general opinion is guided. This is even clearer, of course, in the countries bound to materialism.

We meet up with a very different kind of reality in the correspondence between Pauli and Fierz, a quaternarian one. When travelling to the United States in the beginning of 1956, Pauli wrote a letter to Fierz on January 14 while on board ship, in the background of which one could see an anticipation of where development was headed:

222 Momentan scheint es mir so schwierig, *irgend etwas* zu finden - eine *Aktivität* meine ich - die sich *fortsetzen* lässt. Die Ereignisse des letzten Jahres (einschl. der Diskussionen innerhalb der Physik, die ich hatte) scheinen mir augenblicklich alle so, dass sie sich *nicht* fortsetzen lassen. Wohin die Fahrt?

Mein momentaner Eindruck ist, dass ich *nur scheinbar* nach USA fahre. Wir wollen sehen, wie es weitergeht.

Mit quaternären Grüßen

Ihr

W. Pauli

PLC 0092.164

During the previous year Pauli had given a lecture at Mainz which has already been quoted to a great extent (pp. 96-103). In it he presents in a very condensed and rather complicated fashion those ideas which his correspondence with Fierz covers. The reactions appeared to be quite depressing. In a letter which Pauli wrote from Princeton on January 27, 1956, he told how his young colleague, Res Jost, appointed the previous year, had read his article and took a sharp stand against it:

Wenn ich ihn recht verstanden habe (vielleicht können Sie sich von ihm *direkt* seinen Standpunkt auseinandersetzen lassen), meint er ich hätte zwischen den 2 Elementen des Gegensatzpaares nur einen faulen Kompromiss gemacht, meine ganze Einstellung schmecke ihm zu stark nach Heilslehre, das Gegensatzpaar werde nie zusammen kommen können, denn nach seiner Meinung seien "die Wasser" sub specie aeternitatis hierzu "zu tief".

Gegen eine solche Skepsis scheint mir aber nun z.B. der von Ihnen zitierte Traum zu sprechen (die Niederschrift des Vortrages war viel früher als der Traum): ich weiss, *dass bei mir die "Triebfedern" des wissenschaftlichen Verstandes und die des religiösen Gefühles dieselben sind.* Und das ist eben das, was der in Rede stehende Traum ausdrückt. Jungianisch ausgedrückt ist die "Triebfeder" die Dynamis des Archetypus und der "konstellierte" Archetypus ist die "Conjunctio"! Im "neuen Haus", in der "Kirche" findet diese statt. Es würde sich also darum handeln, diese Erfahrung anderen zu vermitteln (bei Jost ist mir dies offenbar nicht gelungen). Wenn man genügend tief in die Unterwelt hinuntersteigt, dann muss - am Lebensstrom (Styx) selbst - das Gegensatzpaar verblassen. Das wollte ich auch schon in meinem Mainzer Vortrag sagen. Das Wort "Conjunctio" steht dort allerdings nicht (wohl aber ist die Alchemie erwähnt).

PLC 0092.165

At question here is the pair of opposites formed by science and religion. Through my own experience I have seen that Jost represents here the opinion of the great majority of natural scientists. Religion is an object of such strong repression that a dialogue regarding the "conjunction" is quite out of the question.

The latter part of the quotation nevertheless shows that Pauli was not able to give up on this matter, with which his noteworthy, persistently repetitive dreams seemed to be connected. The matter gave him no rest, even though he understood very well what kind of resistance was to be expected. Unfortunately, two years later his death cut short this maturing work which had been important from the point of view of a general development of ideas. Without going into a more detailed interpretation of Pauli's thoughts on such a delicate matter, I wish to offer a bit of additional illumination regarding them with the aid of quotations from two letters. They are from a slightly earlier date, written in 1953:

Wenn ich nun sagen soll, was die "geheime Schrift" für uns Moderne bedeutet, so möchte ich das *Dunkle* als dasjenige

interpretieren, was sich der geistigen, gesetzmässigen (= "lichten") Ordnung zunächst entzieht. Das ist das *Böse* im Ethischen (Problem der Integration des Bösen in der Gottheit etc.), das *Akausale* in der Naturphilosophie. Es ist aber noch offen, wie viel das Akausale ein "blinder" Zufall, d.h. auch ohne *Zweck*-sinn ist (wie in der Quantenmechanik). Wir nähern uns vielleicht der Erkenntnis einer neuen Art von Ganzheitlichkeit sowohl in der Parapsychologie (diese tritt im 17. Jahrh. im Traum des Descartes als "Spuk" auf) als auch in der Biologie. (Es ist mir nämlich unplausibel, dass man beim Verstehen der biologischen Evolution mit dem "blinden" *Zufall* als Auslese-faktor immer durchkommen wird - wie die Neo-Darwinisten es wollen. Sollten dabei nicht äussere Umstände und Mutationen (erbliche Veränderungen der Gene) manchmal ein *unteilbares* (d.h. ganzheitliches) Phänomen gebildet haben?) Das "vital" könnte auf diese *beiden* Gebiete (Parapsychologie *und* Biologie) hinweisen.

Im 17.Jahrh. war aber gerade der Zeitpunkt, wo das "Akausale" (im Protestantismus auch das Böse) nach dem Erfolg der neuen Naturwissenschaft wieder ins Unbewusste verschwand. Die "lichte" Ordnung schien sich in die Natur auszudehnen (siehe den Pantheismus des Giordano Bruno) und die berühmte Spaltung von Religion und Naturwissenschaft begann.

Nun bin ich gespannt auf Ihre Reaktion!

Stets Ihr

W.Pauli

PLC 0092.119

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Wenn ich mich nun wieder an diejenigen spontanen Phantasieprodukte von mir zu erinnern suche (sie erstrecken sich über längere Zeiträume), in denen dieses Thema* auftrat, so erscheinen sie mir auch in der Erinnerung wieder als "bedeutungsvoll" bzw. "bedeutend". So wie wenn es sich dabei um eine Entwicklungslinie handeln würde, die zwar von mir als Einzelnem nur verlangt wird, die aber auch für die *Gesamtkultur* als Weiterbildung des bisherigen, die an Vergangenes in unserem *Okzident* anknüpft, von Wichtigkeit wäre.

Als ich begann, mit Ihnen über diese Sache zu reden, tat ich es unter der instinktiven Voraussetzung, dass bei Ihnen ähnliche

* Pauli refers here to a quaternarian theme associated with music, the contents of which remain unclear as not all letters have been preserved.

Probleme akut sein dürften. (----) Dass Sie so rasch und so ausführlich darauf eingestiegen sind, spricht für die Richtigkeit dieser Vermutung.

PLC 0092.125

Pauli's journey is over, but the problem regarding the general cultural development, to which Pauli refers here, is becoming increasingly actual. There are many who are anxious about where the journey ends.

The Quaternarian Concept of Reality

If the reader has not obtained lucid and exact concept on the basis of the previous presentation concerning what is meant by quaternity and a quaternarian viewpoint, he can hardly be criticized for that. This author is not able to define these matters with such a precision as would satisfy those who put emphasis on logical exactness and are pleased with the formal demands of analytical philosophy. I have run across the concept of quaternity only in my reading of the letters exchanged between Pauli and Fierz. Little by little I have become convinced, however, that this is a question of primary importance. (I would also like to mention in passing that I have simultaneously come to the conclusion that things which can be defined with the accuracy required by analytical philosophy are seldom of first-rate importance.)

Central to the quaternarian attitude are *opposites* and their fusion, *conjunction*. This is based on a particular view of the fundamental structure of reality--*the archetype of quaternity*. This concerns not only knowledge, but also emotions.

The mystical meaning of the number four is based on *two pairs of opposites* which are experienced as essential when trying to comprehend the structure of reality. Fierz seems to have found a very clear model of quaternity in referring to the display of two kinds of opposites in quantum mechanics: polar or compensatory opposites and complementary ones. It is the idea of *complementarity* that appears to clarify the concept of quaternity in a decisive fashion.

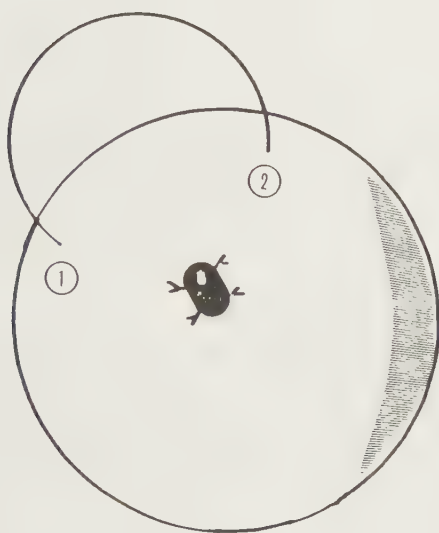
Pythagoras, Kant, and Schopenhauer, as well as Fludd and Goethe, represent the quaternarian attitude according to Pauli and Fierz.

Representatives of the trinitarian attitude include Plato, Kepler, Descartes, Newton, and Einstein. Newton's stand was actually a bit vacillating, but he must nevertheless be counted amongst the trinitarians. In the famous conflict regarding color theory Newton clearly represented trinitarian thought whereas Goethe, the quaternarian view.

The quaternarian conception of reality always contains something which cannot be described with the aid of a logical theory. It is impossible to precisely define it. It belongs to the area of intuition, mysticism and faith. Complementarity helps us to understand that this "irrational" element in reality is not the absolute (polar) opposite of a rational component, but the complementary opposite. For this reason these "opposing" components can be accepted as belonging to the same reality.

As was presented in the chapter "Spirit and Matter", complementarity also opens up the possibility for a concept of reality in which the "physical world" and the "spiritual world" blend into one as complementary components of one reality--in just the same sense as the "rational" and "irrational" constituents of reality. There is no absolute border between complementary opposites, but rather, both complementary components exist in all things. It is in just this regard that I consider complementarity essential in clarifying the concept of quaternity. Matter and spirit become dealt with from a common basis and another road is found to run parallel to the rational one of understanding reality, just as quaternarian thought explicitly presupposes.

For a trinitarian thinker this kind of deliberation sounds confusing and incorrect. Conceptions of reality based upon different archetypes are distinguished by the same kind of gulf as that separating different religious convictions. It appears that the trinitarian view is often as holy an idea to the representative of natural science--as well as to religious fundamentalists--as ever that of a religious conviction. If it is offended, then lightning flashes indeed. Because the trinitarian position has up until now, on the other hand, dominated our culture, the quaternarian thinker must be expelled--if not quite sentenced to the burning pyre then at least isolated from his environment and its support. For this reason, not all people seem to be sure that making Pauli's world view known is welcome and desirable.



The irrational dimensions of the world. The curved line connecting points 1 and 2 on the surface of a sphere, external to the surface, represents for two-dimensional surface beings "irrational connections" between the points 1 and 2.

(By courtesy of the Publishing Co. Kirjapaja, Helsinki)

Transcendental Reality

In the previous chapters I have tried to describe Pauli's philosophical views by attempting a coherent presentation, while nevertheless referring to Pauli's words as exactly as possible--particularly from the correspondence between Pauli and Fierz. Something important is nevertheless missing: some kind of united effort or over-all perspective concerning what Pauli saw as *the fundamental features of reality*.

I have previously characterized Pauli as a *realist*. The conception of reality which was the background to Pauli's thought was nevertheless something quite different from the "realism" which has been the goal of the basic research of quantum mechanics during the past two or three decades.

There is a particularly great danger of subjectivity when I now attempt to describe Pauli's conception of reality. I consider it to be necessary here to add some clarifications to what comes out clearly from Pauli's own words. This final chapter in this regard differs a bit from the previous sections. The distinction is not great, but there is reason to make particular note of it.

Synchronicity

It has already been stated that Pauli was not able to form a sufficiently clear conception of the coincidences which Jung referred to as *synchronicity*. There is reason now to return to this. This question regards matters which tie the articles of Pauli and Jung together in their co-published work, "Naturerklärung und Psyche" (The Interpretation of Nature and the Psyche). Pauli considered the connection between his own thought and that of Jung's to be so important in this respect that he forbade the translation of his article on Kepler into English without Jung's article on synchronicity.

A suitable introduction to the matter can be found in Pauli's letter to Fierz on June 3, 1952:

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In diesen Tagen geht ein Exemplar des Bandes an Sie ab, der C.G.Jungs Synchronizitäts- und meine Keplerarbeit enthält. Bei dieser Gelegenheit möchte ich nicht nur nochmals danken für Ihre

verschiedenen ermutigenden Bemerkungen sondern diesem letzten Kind von mir auch noch einen Kommentar mitgeben.

Das hier "konstellierende" zentrale Problem ist m.E. das "*psycho-physische*". Mehr und mehr kam ich zur Überzeugung, dass der im Anschluss an Leibniz u. Spinoza ausgebildete Begriff des "Parallelismus", vom Standpunkt der *klassischen Physik* aus betrachtet, illegitim und "erschlichen" wird (siehe p.169; siehe hiezu auch C.G.Jung, p.91). Denn wenn alles deterministisch-kausal sein soll, gibt es m.E. keinen Platz für eine andere Art von Zusammenhang, die etwa statt mit "kausal" mit "parallelistisch" zu bezeichnen wäre. Daher das Vorhandensein des "psycho-physischen Parallelismus" getauften geistigen Nebelfleckes ebenso ein Hinweis auf die Unvollständigkeit des klassisch-naturwissenschaftlichen Weltbildes ist wie z.B. der licht-elektrische Effekt und das Wirkungsquantum. Es ist mir daher befriedigender zu denken, dass es die *akausale* Art des Zusammenhanges, die "psycho-physischer Parallelismus" genannt wurde, qua "Angeordnet-sein" bzw. "Korrespondenz" *sonst auch* geben muss und nicht nur speziell bei Psyche-Physis.

C.G.Jung hat versucht, den Zusammenhang Psyche-Physis mit seinem "Synchronizitäts"-phänomen (Abkürzung: Σ) in Verbindung zu bringen (siehe Fussnote 2), p.85/86). Aber dabei entstand eine prinzipielle Schwierigkeit, auf die ich nachdrücklich hingewiesen habe und die Jung dann (pp. 103 - 104) ausdrücklich in Betracht gezogen hat: Die von ihm betrachteten Synchronizitäts- (Σ -) phänomene im engeren Sinne, entziehen sich der Einfangung in Natur- "gesetze", da sie nicht-reproduzierbar d.h. einmalig sind und durch die Statistik grosser Zahlen *verwischen* werden. In der Physik dagegen sind die "Akausalitäten" gerade durch statistische Gesetze (grosse Zahlen) *erfassbar*. Vollkommen reproduzierbar, sozusagen stets vorhanden, sind ferner nicht nur alle psycho-physischen Zusammenhänge, sondern auch solche empirischen Tatsachen wie der Fernsinn vieler Tiere (Zugvögel etc.) und in gewissem Sinne auch die von Rhine angegebenen Effekte, die gerade durch die Statistik bei grossen Zahlen *hervortreten* (NB. Jungs astrologische Untersuchung in Kap.II scheint mir völlig missglückt).

Es tritt daher bei Jung ein gewisses unsicheres Schwanken in der Auffassung der Σ -Phänomene ein, indem er bald Reproduzierbares, bald wieder Nicht-reproduzierbares u. Seltenes dafür in Betracht zieht (NB. Erstere Σ -Phänomene im engeren Sinne würde ich lieber als "Sinn-korrespondenz" denn als " Σ ",

ohne explizite Hervorhebung des *Zeit*-begriffes, bezeichnen). Mir persönlich wäre es viel lieber, mit allezeit *reproduzierbaren* "akausalen Anordnungen" (einschliesslich denen der Quantenphysik) zu beginnen und zu versuchen, die psychophysischen Zusammenhänge als Sonderfall dieser allgemeinen Spezies von Zusammenhängen zu begreifen (wie dies ja auch N.Bohr versucht).

So erscheint mir das Kap.IV der Arbeit von Jung noch etwas anderes zu sein als eine "Zusammenfassung": es erscheint mir als C.G.Jungs geistiges Testament, das von der speziellen "analytischen Psychologie" wegdrängt in die Naturphilosophie im allgemeinen und das psycho-physische Problem im Besonderen.

Gerne möchte ich Ihre Ansicht hören. Inzwischen alles Gute für Paris. Ich bin in Kopenhagen vom 8. bis 15. Juni.

Viele Grüsse

Ihr

W. Pauli

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Synchronicity opens up the possibility of bringing light "to the twilight of parallelism", to which the separation between the worlds of matter and of spirit accomplished by Descartes led. In addition to the causality of the physical world something more is needed to help us in understanding this world and our place in it. The manner in which causality was understood during the Modern Age involved an emphasis on the rational: it expressed faith in the possibilities of logic-mathematical description for comprehending reality. Synchronicity is a specifically non-causal feature of reality. But is it in any sense rational? Can synchronicity be defined in any way such that it can be considered a rational concept?

The examples which Jung gives of synchronicity are generally *coincidences* which have a tremendous psychological significance to a certain individual but which are by their nature *unique*. Pauli emphasized here that among the non-causal "connections" (Zusammenhang) there also seem to exist *repeatable* ones. The relation of the psyche to the body is a stable one and for this reason it must contain something which can be scientifically analyzed. If one attempts to carry out research on this relation with the aid of standard methods of empirical science, the investigation will be centered on an analysis of causal relationships, and thus will not be able to be freed from the "phenomenal world" and as a result will not enter the ordinary "world of the soul". The soul seemingly escapes beyond the reach of the researcher. If one wants to investigate the relation between the "spiritual world" and the "physical world" some basis other than that of

causality is necessary; Pauli hoped that the idea of synchronicity could bring about something more lucid into the place of "parallelism".

Pauli has in his work on Kepler referred to the lesson which atomic theory has given. When causality is statistical it presupposes an indeterminism alongside the determinism of events. Causality achieves only statistical mean values. Pauli looked at the indeterminism of the individual events as a kind of "road sign" to something new which Jung, on the other hand, aimed at reaching on the basis of the concept of synchronicity.

In a letter quoted earlier (November 26, 1949; p. 32) Pauli considered the "statistical correspondence" of quantum mechanics to be something between the absolute causality of classical mechanics and the "non-causal order" which Jung called synchronicity. Just what this "non-causal order" or "connection without cause" ("ursacheloses Angeordnetsein") really meant was something which Jung was only able to explicate with the aid of some allusions. According to Jung also, the statistical causality in nuclear physics, a good example of which was the law of radioactive disintegration, is a hint at synchronistic phenomena.

Synchronicity in atomic theory is contained in the idea of "chance", deeper investigations into which are considered to be in vain. It is sufficient to the physicist that he be able to control phenomena to the degree of accuracy allowed by the laws of probability--and that is already quite a bit. Jung and Pauli, however, were interested in what lies hidden within the term of "chance". It was from just this point that they started upon their new road. Neither the sworn-in materialist nor the "science-believer" wants to see any new road: "weil nicht sein kann, was nicht sein darf" (p. 31).

Personally, I tend to feel that the "non-causal order" which Jung speaks of may not be at all possible to dress in scientific garb. Perhaps it is a question about an essentially non-rational matter which does not belong to the sphere of reason, but rather to the region of *will* and *faith*.

Of course, it is strange to speak about "will" and "faith" when the point at question is radioactive disintegration or some other phenomena of "inanimate nature". But isn't it so that the whole concept of "inanimate nature" has been launched only with the science of the Modern Ages and through the strengthening of materialism? Pauli wrote in many connections that "spirit" participates in everything which takes place, and therefore also in the events of so-called inanimate nature. It is not that the radioactive nucleus possesses a "will" by which it decides when it will disintegrate, but that in all events one can see a "will" and a "striving" towards some goal. This means a return to Aristotelian thought in a new form, according to which *teleology* is manifested in everything that goes on. In the empirical

sciences, which analyze causal relations, it is not discussed, but from the point of view of life and activity it is an essential part of reality. Its "reality" must be grasped through intuition. It is a matter of faith, not of reason. Life also contains something quite different from rationality, something just as important if not even more fundamental than the intellectual understanding. And it deals precisely with changes, the creation of something new.

The Western culture, in placing an over-emphasis on the rational is in error if it denies the existence of this other fundamental constituent of reality. This culture experiences ever more serious repercussions due to this error. For this reason "green movements" are needed as well as the development of creativity alongside the development of the intellect. Faith is also needed, to provide a basis for values and morals.

Maybe what Jung termed "synchronicity" is not properly a matter of science. There is another road toward the understanding of reality alongside that of rational knowledge: the way of intuition and mysticism. We see a glimpse of the depths of reality's irrational aspects in the synchronicity phenomena which Jung describes.

Rational knowledge can hardly ever find an explanation for such experiences of destiny. This does not mean that these phenomena would not be of interest from a scientific point of view. Intuition is important in science, too, nor is there any absolute border between the rational and the irrational. They are complementary opposites just as faith and knowledge. The main point is that the reality of both be understood. The causal analysis based on reason can never reach all the dimensions of reality, nor knowledge replace faith.

Observer and Observed

Pauli has written of the following notes that they are not suitable in this form for a public exchange of opinions, but I will nevertheless quote from them because they illuminate matters from an important viewpoint. This concerns a letter to Fierz on August 10, 1954:

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Dies alles führte mich dann auf weitere, etwas mehr phantastische Gedankengänge. Es könnte doch sein, dass wir die Materie, z.B. im Sinne des *Lebens* betrachtet, nicht "richtig" behandeln, wenn wir sie so beobachten wie wir es in der Quantenmechanik tun, nämlich vom inneren Zustand des "Beobachters" dabei ganz absehend.

Es kommt mir so vor, wie wenn die nicht beachteten "Nacheffekte" der Beobachtung dann *doch* eintreten würden (als

Atombomben, allgemeine Angst, "Fall Oppenheimer" z.B. etc.), aber in einer *unerwünschten Form*. Die berühmte "Unvollständigkeit" der Quantenmechanik (Einstein) ist doch irgendwie irgendwo tatsächlich vorhanden, aber natürlich gar nicht behebbar durch Rückkehr zur klassischen Feldphysik (das ist nur ein "neurotisches Missverständnis" Einsteins), sie hat vielmehr zu tun mit *ganzheitlichen Beziehungen zwischen "Innen" und "Aussen"*, welche die heutige Naturwissenschaft nicht enthält (die aber die Alchemie vorausgeahnt hat und die sich auch in meiner Traumsymbolik nachweisen lässt, von der ich meine, dass sie gerade charakteristisch die eines heutigen Physikers [sei]).

Ich bin mit diesen vagen Gedankengängen an die Grenze des heute Erkennbaren gekommen und habe mich sogar der "Magie" genähert. (Von diesem Standpunkt kann einem die Beobachtung in der Quantenmechanik sogar wie eine "schwarze Messe" erscheinen, nach welcher die "misshandelte" Materie, indirekt "sich rächend", ihre Gegenwirkung gegen den "Beobachter" als "hinten hinausgehenden Schuss" manipuliert). Dabei bin ich mir darüber klar, dass hier die drohende Gefahr eines Rückfalles in primitivsten Aberglauben besteht, dass dies noch viel schlimmer wäre als Einsteins regressives Gebunden-bleiben an die klassische Feldphysik und dass alles darauf ankommt, die positiven Resultate und Werte der ratio dabei festzuhalten.

Dessen eingedenk habe ich nunmehr "meines" *Schopenhauers* Aufsatz "Animalischer Magnetismus und Magie" wieder vorgenommen (es ist recht lange her, dass ich ihn gelesen habe). --Man wird ja den Autor nicht gerade eines "primitiven Aberglaubens" bezichtigen. Er ist auch recht kritisch zum empirischen Material, geht aber recht weit in der Anerkennung der "magischen Bewirkungen". Er geht sogar so weit--bei aller Betonung der Grausamkeit der Hexenprozesse--über "die Hexerie" zu sagen: "Wenn sie gleich in den allermeisten Fällen auf Irrtum und Missbrauch beruht hat, so dürfen wir doch nicht unsere Vorfahren für so ganz verblendet halten, dass sie, soviele Jahrhunderte hindurch, mit so grausamer Strenge ein Verbrechen verfolgt hätten, welches ganz und gar nicht möglich gewesen wäre."..."Um über alle geheime Sympathie, oder gar magische Wirkung, vorweg zu lächeln, muss man die Welt gar sehr, ja, ganz und gar begreiflich finden. Das kann man aber nur, wenn man mit überaus flachem Blick in sie hineinschaut, der keine Ahnung davon zulässt, dass wir in ein Meer von Rätseln und

Unbegreiflichkeiten versenkt sind und unmittelbar weder die Dinge, noch uns selbst, von Grund aus kennen und verstehen."

Das Interessante für uns ist aber, dass Sch[openhauer] jene "magischen" Effekte geradezu als *empirische Bestätigung seiner Philosophie* ansieht! Man müsse nämlich (nach Kant) "die Erscheinung" vom "Ding an sich" auseinanderhalten und letzteres sei eben "der Wille" sowie auch "unser eigenes inneres Selbst". Ausser dem "nexus physicus" gäbe es noch eine andere Verbindung zwischen den Erscheinungen dieser Welt, eine "durch das Wesen an sich aller Dinge gehende", "gleichsam eine unterirdische Verbindung", den "nexus metaphysicus"... "Wie wir kausal als *natura naturata* wirken", sind wir "auch wohl eines Wirkens als *natura naturans* fähig", der sogar das "principium individuationis" (= Raum u. Zeit, siehe oben) durchbrechen könne--etwa: die Einheit bricht durch die Vielheit durch. Und dies alles soll nach Sch. "dem inneren Gefühl der Allmacht des Willens an sich" entspringen. Es gibt nach Sch. "ein *unmittelbares* Wirken vom *Wesen* der Dinge an sich, also von Innen auf die Natur", während "das Kausalitätsgesetz bloss das Band der *Erscheinungen*" sei.

Die Jung'sche Schule würde statt "das Wesen der Dinge an sich", das "kollektive Unbewusste", statt "Willen" etwa "der einem energetischen Gefälle folgende Strom der Archetypen in seiner Beziehung zum Bewusstsein", statt "metaphysicus" "psychologicus" sagen.

In der Quantenmechanik wird sich der Physiker zum ersten Mal bewusst, dass er nunmehr auch "*natura naturans*"¹ spielt--kein Wunder, dass es erst einmal schief geht--denn "aller Anfang ist schwer."

Eine meiner Entschuldigungen für die Länge dieses Briefes an Sie ist, dass Sie (mit Ihrem Brief vom 20. Mai) alle diese Gedankengänge (sind es Tag- oder Nachtgedanken?) bei mir ausgelöst haben als einen Versuch, ein mir wohl vertrautes gefühlsmässig-emotionales Erleben unserer heutigen Physik auch von der naturphilosophischen Seite her zu erfassen.

In diesem Sinne viele Grüsse
Stets Ihr
W. Pauli

(1) Ich erinnere mich, daß wir vor langer Zeit einmal über die termini "*natura naturans*" und "*natura naturata*" sprachen, weil sie

in einem Traum von mir vorkamen. Wir haben damals auch eruiert, daß diese im Mittelalter sehr geläufigen termini bei Averroes vorkommen, auch bei Nicolaus Cusanus, viel später bei Spinoza. Ich bin nun sicher, daß mein Traum von damals eine Kryptomnesie aus diesem Artikel von Schopenhauer war.

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One can see from this letter that the phenomena classified under the field of parapsychology were not foreign to Pauli, nor were the ideals of the Green movement, which has become increasingly stronger nowadays. Pauli has written in various connections that he feared the unpredictable consequences which could result from an incorrect handling of nature by empirical science. Schopenhauer's concept of the world of the "thing in itself", producing effects from within on the phenomenal world and being characterizable as an irrational "will", was close to Pauli's thought. In the term "will" he saw something similar to that of the "anima mundi" of Neoplatonism: it is a ubiquitous, all-supporting unity, which opens up certain kinds of "subterranean" connections between phenomena.

As Pauli has noted, the idea of noncausal relations and influences opens the way to the most savage superstitions and magic. It is thus a dangerous way that is in question and it is on just this basis that many reject such ideas. Pauli, however, saw even greater danger in their repression. He has even said that a misinterpretation of matter can take "revenge" on man if the psyche's role is not taken into account. It is just this one-sidedness which characterizes the general trend towards "realism" today, in the sense that the physical world is considered independent of the psyche. One tends to see the "observer" as "detached", which implies the exclusion of any irrational element from the picture of the world.

In Anglo-Saxon countries, and nowadays quite generally elsewhere also, the empirical conception of reality is quite general, and only with difficulty does one actually adjust to anything the existence of which cannot be verified and explained by the standard empirical method, that is, by causal relations. The heart of the concept of reality actually corresponds closely to a naive realism: it is assumed that observations give in and of themselves a reliable picture of reality. In this way the active participation of man's psyche in the formation of all basic observations, which Kant especially has emphasized, is completely ignored. In particular, the fact that we observe everything in a framework of space and time is an effect of man's psyche, nor does it in any way necessarily correspond to the structure of "reality itself". The theories of relativity and quantum mechanics have forced the physicist to surrender his naive realism, but it has been replaced

by somekind of positivistic or instrumentalist attitude and some sort of fear of philosophy since the struggles over philosophical principles have proven to be quite problematic.

If we seriously examine the principles of the philosophy of quantum mechanics, it becomes necessary to release our naive realism which claims that our observations reveal directly certain properties of the "outside world" to us, independent of whether or not we observe the object. The observer partly creates with the strength of his own psyche the external world which he observes. This is what Pauli means when he writes that the physicist affects the physical world not only in the sense of "natura naturata" (created nature), but also as "natura naturans" (creative nature). This changes the basis of our picture of the world. No one can say at this moment what all of this implies but a great deal of things which science has not previously been willing to approve of now have to be accepted as being a part of reality. The situation is the same as that in the beginning of the Modern Ages when the distinction between the "sublunar world" and the "superlunar world" was wiped out. During the 16th century astronomers began to find "new stars" flaring up in the "superlunar world" which according to the dominant concept of reality was impossible because no changes could take place in that world; because of this doctrine no new stars had earlier been observed. The influence of our concept of reality on our observations is so strong.

Materialistic prejudices prevent us now from taking seriously the possibility that reality contains "spiritual influences" which can be manifested in events just as clearly as material causes, which alone empirical science validates as real. I do not understand why even some theologians--there are actually very many of them--can accept the idea that the spiritual world has no real interaction with the physical world. Only if matter and spirit are understood to be complementary components of reality, between which there is a true interaction, can the decisions of the will, which are considered as belonging to the spiritual world, truly influence the events of the material world. This does not mean that the causal laws of the "material world" (Kant's "phenomenal world") would not be valid, but rather, that the nature of causality is such that it also allows decisions made on the basis of free will, as was already pointed out in Chapter V.

The Veiled Reality

What is the general view of reality then, assuming that we, like Pauli, accept the idea of the irrationality of reality--*i.e.*, that the indeterminism of events expresses something which must be viewed as an essential

"principle" or "element" of reality? How does this irrationality alter our conception of reality?

Pauli wrestled very much over the question of the relation between our concepts and our observations, which is, of course, a central question in epistemology. Concepts belong to the area of our psyche, "observations" to the external phenomenal world or at least are expressions of its influence on our psyche. The fact that a theoretical picture of the world which is constructed at the basis of our concepts in some sense "corresponds to observations", forms the foundation of empirical science. This correspondence between the world of ideas and that of observations, which in the Modern Ages has advanced to an incredible extent, is truly remarkable.

Archetypes opened up to Pauli--as well as to Jung--a way for the understanding of these matters. Archetypes are a part of the unconscious region of our psyche. They define our instinctual reactions to stimuli arising from the external world. As an effect of archetypes we see certain "shapes" (Gestalt) in the world and form particular concepts. They also guide us in the analysis of our observations. Archetypes are mysterious factors in the unconscious region of our psyche which arrange sensory stimuli according to given patterns and thus create man's picture of the universe. They are the principles of operation of our psyche and characteristic of its nature.

Archetypes are thus a part of man's *psyche*. But the picture of the external world which we ourselves form is also essentially due to the operation of archetypes. Archetypes also shape our observations of the regularity of the external world and of its causality as we experience it. They form a bridge which joins concepts to observations. *Archetypes are expressions of a cosmic order which is verifiable both in our observations of the external world and in the structure of the internal world of our psyche.*

Thus it was that Pauli did not consider archetypes to be merely a part of the unconscious region of the psyche, but rather, just as much a property of the order of the external world. *"The ordering and regulating must be placed beyond the difference between 'physical' and 'psychical',"* wrote Pauli to Fierz on January 7, 1948. The laws of nature of the physical world are in this way a physical expression of the archetypes. That "ordering and regulating"--the archetypes--is something common to the structure of both the external world and that of the psyche.

Pauli and Fierz considered, therefore, physics and psychology as complementary ways to reality. Here we, of course, speak of a reality to which the psychic and the physical, "observer" and "observed", belong as inseparable components, neither of which can be cut away.

On the basis of my personal experience I agree whole-heartedly with this perspective. When thinking of the nature of statistical causality I end up with a concept of reality, the fundamental principles (elements) of which could be described by the terms "reason" and "will". "Reason" is found expressed in the causal relations of reality. "Will", on the other hand, signifies the freedom of choice between possibilities. Reason is represented by determinism, the will by freedom--indeterminism. The "will" is free, but this freedom is nevertheless always restricted by a certain causality which ensures that the whole is causal: statistical mean values can be causally described.

Research into the foundations of quantum mechanics went astray when it aimed at a picture of the world which would be "independent of the observer" and for some of the researchers also--particularly in hidden variable theories--at eliminating indeterminism by transferring to a "description of reality on a deeper level". The physicists' unconscious ontological and epistemological ties and in particular the severe criticism of philosophers have had the effect that development has taken this unfortunate direction which will scarcely take physics any further ahead.

A couple of important perspectives must be mentioned in particular in this connection. It has been said that the influence of the "observer's psyche" on the object to be observed is an impossibility at least when you are using automatic apparatus, the outcomes of which can be read at any length of time after the observation has taken place. This comment is not correct however. Automatic apparatus is in any case planned by our psyche, created on a theoretical basis, and the results must correspondingly be interpreted in a given manner. Even though the results can afterwards be objectively verified, the chosen experimental set-up causes, even in this case, in each individual event a "noncalculable disturbance in nature", as Pauli commented in his letter to Bohr on February 15, 1955 (p. 61).

A situation in which automatic apparatus is employed is the same in principle as any other observation. The psyche even in this case has an influence on what results are obtained and how they are interpreted, and the indeterminism of individual events is not eliminated.

It must, however, again be stated that the observations in the natural sciences are always set up so as to minimize subjectivity. This does not imply that the observations attain an *objective reality*, as the empirical scientist in particular is used to imagining. His results are indeed--at least it is aimed at, anyway--*intersubjective*; the competent representatives of the science in question are of one accord concerning this interpretation. This does not, however, mean the same as the effect of the human psyche being eliminated.

Particularly those persons who have obtained education in the humanities find it very difficult to accept the idea that the statistical nature of the atomic world could have anything to do with the free will--this regards, indeed, the totally separate sphere of spiritual life! There is no reason to speculate here about what implications the uncertainty principle of atomic physics could have from the point of view of neuro-physiology. (It can actually be significant.) The matter should not be dealt with from a reductionist point of view. Instead, there is reason to focus attention on the fact that the basic structure of reality which corresponds to the idea of statistical causality appears to have interesting implications also for the psychic world. The idea of statistical causality opens up a new perspective on both the physical and the psychic world and it was into just such matters that Pauli wanted to focus particular attention. Reality, which includes both the material and the spiritual world, appears to possess a basic structure which corresponds to the idea of statistical causality. On the other hand, in Chapter VI it has been stated that statistical causality leads to the introduction of irrationality. There is therefore reason to believe that reality, which includes both the physical and the psychic world, contains a fundamentally irrational element.

As I see it, the remarks which many significant representatives of atomic theory have made regarding the change in our conception of reality due to quantum theory have been pushed aside too hastily. The matter has evidently been influenced by a conception according to which the spiritual world is quite different in its basic nature from that of the material or "phenomenal" world, as Descartes and Kant have taught us to believe. On the other hand, natural scientists have become so much estranged from religion that they wish to keep any thought related to religion absolutely separate from natural science. Ideas which for these reasons have been sharply repressed have been presented, for example, by Eddington and Jordan, who have also had--as has Pauli--the Copenhagen interpretation of quantum mechanics as a starting point. As this writer also has had.

If reality contains both a physical and a psychic aspect--and, a fortiori, both a rational and an irrational aspect--it cannot be exhaustively described using only rational concepts. The only way to attempt to describe the most important characteristics of reality is *with symbols*. This is the traditional way to picture matters which cannot be attained other than with the aid of intuition--as in myths. Pauli wrote (in a letter to Fierz on August 12, 1948):

Was mir unter der neuen Wirklichkeitsidee vorschwebt,
möchte ich versuchsweise nennen: *die Idee der Wirklichkeit des
Symbols.*

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Even after all the progress of science the description of reality is nevertheless of the same nature as it was when religious myths were the only way for describing its fundamental characteristics! We can never attain reality itself through our conceptual thinking and our words. We can only speak about it in metaphors and pictures. Reality itself lies *behind a veil*.

The Irrational Dimensions of Reality

Reality seems to be by nature such that it will always remain *transcendental* for us. The symbols with the help of which we seek to describe it can nevertheless be very exact. Mathematics is often an irreplaceable tool. The four-dimensional picture of the world in the theory of relativity, for example, gives a certain view of reality and in this regard both mathematical equations and geometric analogies can be used for the elucidation of the matter. It must, however, be understood that this is a rational picture, outside of which remain the irrational dimensions of reality.

On the basis of the four-dimensional world picture of relativity theory we can nevertheless also obtain a certain kind of elucidative description for what the irrationality of reality means. A two-dimensional surface (for example, the surface of a sphere) we imagine according to our innate ability as being "submerged" into three dimensional space. We cannot think of the ball's surface other than as a part of three-dimensional space. On the surface we can imagine two-dimensional creatures who can experience only the surface's two dimensions and are unable to imagine a three-dimensional space in which their own surface is "submerged". The third dimension is to them "irrational".

With the help of a similar image we can also gain insight into how three-dimensional space can be thought of as "submerged" into a four- or more dimensional space and the four-dimensional space-time of relativity as "submerged" into a five- or more dimensional space.

In just this way we can imagine the observationally comprehended (four-dimensional) world of place and time as being "submerged" into a multi-dimensional reality whose other dimensions besides the familiar ones of length, breadth, height and time are irrational for us. Thus, we are not able to describe their nature even with the aid of geometric analogies, but we can form somekind of picture of the world of place and time as submerged into a multi-dimensional reality.

With the aid of this kind of description we are able to imagine some kind of "underground connections" which exist between phenomena, about which Schopenhauer and Pauli spoke: things in the world of place and time

display connections with one another with the aid of irrational dimensions in the same way that two points on the surface of a sphere can be connected to one another by a line which does not go at all along the surface of the sphere, but rather, external to it, in the third dimension which is "irrational" from the point of view of the two-dimensional surface creatures. In this way it is possible to get some idea of the irrational connections which are of quite a different nature from that of the causal connections familiar to us from science.

This is nevertheless all a matter of descriptions through analogies and metaphors. Rational descriptions never attain reality itself, rather, very fundamental matters remain beyond its reach.

Western culture has blinded its eyes by staring so intensely at the rational models which empirical science has conjured up before us. Quite common is the illusion that reality as a whole can be attained in this manner: one claims to solve all the questions regarding reality via scientific means. *This is precisely the illusion which Pauli warned us against.* Reality possesses dimensions which cannot be grasped in this way. If we disregard these dimensions, our culture will be led in the wrong direction. This is just what Pauli meant when he repeatedly made the remark that "we went too far in the 17th century" and that an incorrect handling of nature would bring "revenge": matter, whose connection with the psyche has been totally severed by our science and technology, may "react" in such a way that the human psyche may be wiped off the face of our planet.

In this chapter I have used, to some extent, personal forms of description. I nevertheless believe that the basic ideas presented here are quite close to what Pauli intended when he spoke of these matters in a manner often rather difficult to comprehend. It is necessary to state, however, that Pauli was a free-thinker who said that his God-picture was closer to that of the Yahweh of the Old Testament than to the Christian picture of a loving Father: he wanted to emphasize that God is also a fearful and destroying God. Let the representatives of Christian theology consider whether it is a heresy to emphasize these circumstances and the testimony of Nature, or whether it is actually healthy criticism regarding a tendency which has been inherent to Christianity and perhaps particularly to Protestant theology, and which tendency Pauli referred to as a *repression of the irrational and the evil*.

Let us repeat in the end once again Pauli's own words which contain the core of the matter, in a letter to Fierz on August 12, 1948:

Der Laie meint gewöhnlich, wenn er "Wirklichkeit" sagt, spreche er von etwas Selbstverständlich-Bekanntem; während es mir gerade die wichtigste und überaus schwierige Aufgabe

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unserer *Zeit* zu sein scheint, daran zu arbeiten, eine neue Idee der Wirklichkeit auszubauen. Dies ist es auch, was ich meine, wenn ich immer betone, dass Wissenschaft und Religion etwas mit einander zu tun haben *müssen*.

APPENDICES

Wolfgang Pauli and the Copenhagen Philosophy *

1. Pauli's Role in the Creation of Quantum Mechanics

Heisenberg has, in a lecture given in 1968 in Trieste [1], described Wolfgang Pauli's attitude as follows:

Pauli's whole character was different from mine. He was much more critical and he tried to do two things at once while I would think that this is really too difficult for even the best physicist. He tried first of all to be inspired by the experiments and to see in a kind of intuitive way how things are connected, and at the same time he tried to rationalize his intuitions and to find a rigorous mathematical scheme so that he really could prove anything what he said. Now this is, I think, simply too much, and therefore Pauli has through his whole life published much less than he could have published if he had abandoned one of these two postulates. Bohr had dared to publish papers which he could not prove and which were right after all. Others have done a lot by rational methods and by good mathematics, but the two things together that I think is too much for one man.

Here, Heisenberg was thinking of his last collaboration with Pauli in 1957–58, from which Pauli withdrew in August 1958 by sending many particle physicists his famous circular letter concerning the "Isospin group in Theory of Elementary Particles". Heisenberg continues:

Pauli was completely disappointed, when he saw the difficulties, and so he gave up in a rather sad way. He told me that he felt that his thinking was not strong enough any more and that he was not well at all; but he encouraged me even after he had withdrawn his approval for the publication. I should go on, he said, but he could not continue and as you know, unfortunately he had to die half a year later. This was rather a sad end to my long friendship with Pauli and I can only say that I regret even now almost every day that I cannot have his very strong criticism which has helped me so many times in my life in physics.

*Lecture in Joensuu on June 18, 1985. Published in *Symposium on the Foundations of Modern Physics: 50 Years of the Einstein-Podolsky-Rosen Gedankenexperiment*, Joensuu, Finland, 16-20 June 1985; eds. P.Lahti and P.Mittelstaedt; World Scientific, 1985; pp.273-287.

This is one statement of Pauli's criticism. He also had the questionable fame of having restrained people from publishing their ideas. Maybe this was true in some cases, but Pauli was even more critical with respect to his own ideas. Correspondence and discussions were, for him, essential parts of the scientific activity. In this form Pauli has given many people valuable insights which have resulted in their publishing articles. For this reason one cannot form a complete idea of Pauli's importance for the development of physics without studying his letters.

Some examples of Pauli's hidden contributions to the creation of quantum mechanics and its interpretation must be mentioned here [2]. For those who have studied the first volume of Pauli's scientific correspondence, published by Springer, these cases are well-known.

It was Pauli who first began to speak of the necessity of abandoning the exact kinematical description of the electronic motion in atoms. In December 1924 Pauli wrote to Bohr [3]:

Die relativistische Dublettformel scheint mir nun zweifellos zu zeigen, dass nicht nur der dynamische Kraftbegriff, sondern auch der kinematische Bewegungsbegriff der klassischen Theorie tiefgehende Modifikationen wird erfahren müssen. (Deshalb habe ich auch die Bezeichnung "Bahn" in meiner Arbeit durchweg vermieden.) Da dieser Bewegungsbegriff auch dem Korrespondenzprinzip zu Grunde liegt, so müssen seiner Klärung vor allem die Anstrengungen der Theoretiker gelten. Ich glaube, dass Energie- und Impulswerte der stationären Zustände etwas viel realeres sind als "Bahnen". [I believe that the energy and momentum values of stationary states are something much more real than the orbits.]

Das (noch unerreichte) Ziel muss sein, diese und alle anderen physikalisch realen, beobachtbaren Eigenschaften der stationären Zustände aus den (ganzen) Quantenzahlen und quantentheoretischen Gesetzen zu deduzieren. [It must be the aim (not yet achieved) to deduce these and other physically real, observable properties of stationary states from the (integer) quantum numbers and from the laws of quantum theory.] Wir müssen aber nicht die Atome in die Fesseln unserer Vorurteile schlagen wollen (zu denen nach meiner Meinung auch die Annahme der Existenz von Elektronenbahnen im Sinne der gewöhnlichen Kinematik gehört), sondern wir müssen umgekehrt unsere Begriffe der Erfahrung anpassen.

These remarks savour of positivism – as an inheritance from Pauli's godfather Ernst Mach; one should eliminate the electron orbits from the theory, because one cannot observe them, and put the emphasis on "physically real, observable properties of stationary states". This program materialized half a year later in Heisenberg's first article on quantum mechanics [4]. (Heisenberg was in Copenhagen, when Bohr received Pauli's letter.)

At this time, positivistic philosophy influenced Pauli's thought. He admired Einstein's thinking, and the theory of relativity begins from a positivistic criticism of the concepts of space and time. Pauli also criticized these

concepts in many connections, especially the uncritical use of the space-time continuum in microphysics. His general philosophical attitude, however, changed later from positivism towards realism, as will be seen shortly.

Another case where Pauli gave valuable insights to Heisenberg, also concerns the space-time description of microevents. In a very long letter to Heisenberg of October 19, 1926 Pauli writes:

So weit die Mathematik. Die Physik davon ist mir noch weitgehend unklar. Die erste Frage ist, warum denn nur die p 's und jedenfalls nicht sowohl die p 's als auch die q 's, beide mit beliebiger Genauigkeit vorgeschrieben werden dürfen. [So much about mathematics. The physics therein is for me still, to quite an extent, unclear. The question is, why one can only give the p 's and in any case not both the p 's and also the q 's with an arbitrary accuracy.] . . . Es ist immer dieselbe Sache: es gibt wegen Beugung keine beliebig dünnen Strahlen in der Wellenoptik des ψ -Feldes, und man darf nicht gleichzeitig den " p -Zahlen" und den " q -Zahlen" gewöhnliche " c -Zahlen" zuordnen. Man kann die Welt mit dem p -Auge und man kann sie mit dem q -Auge ansehen, aber wenn man beide Augen zugleich aufmachen will, dann wird man irre. (One can look at the world either with the p -eye or one can look at it with the q -eye, but if you will simultaneously open both eyes, you get lost.)

Most of Pauli's letters to Heisenberg from this time were lost during the war, but one can see from this correspondence, however, that an essential preparatory work for Heisenberg's article about uncertainty relations has been made there [6]. In a footnote of his article [7] Heisenberg thanked Pauli for stimuli obtained from Pauli in discussions and in correspondence.

The third example of Pauli's "invisible" influence upon the creation of quantum mechanics is from the spring of 1927. Bohr and Heisenberg had by then got into difficulties because of their different views about the interpretation of quantum mechanics. While Bohr emphasized his complementarity idea, Heisenberg considered uncertainty relations as the correct basis for the interpretation. In this situation Pauli's visit to Copenhagen in June of 1927 seems to have been very clarifying. After this visit Bohr and Heisenberg considered their solutions for the interpretation problem as different aspects of one and the same interpretation [8].

I am inclined to understand these discussions in such a manner that Pauli, from the very beginning, saw deeper than both Bohr and Heisenberg in philosophical questions. I shall try to show that Pauli was the most consistent representative of the philosophical attitude which can be discerned behind the original Copenhagen interpretation and which I shall call the *Copenhagen philosophy*.

2. What is the Copenhagen Interpretation?

Today many people would like to abandon the term "Copenhagen interpretation". Usually Bohr and Heisenberg are considered as the proper representatives of the Copenhagen philosophy, and since there are essential dif-

ferences in their attitudes, the very idea of the Copenhagen interpretation is found to be unclear.

One should not, however, forget Pauli in this connection. He was a “hidden parameter” in the Copenhagen philosophy. After having studied Pauli’s thought over a number of years, my definite opinion is that Pauli’s competence in philosophical questions concerning the foundations of physics was greater than that of most scientists of the 20th century. He not only demonstrated his competence in physics, he was also always interested in philosophy, and during the last ten years of his life, he made a tremendous effort in studying philosophy and the history of ideas in order to judge the present situation in physics and its importance as a part of the Western culture. In this respect Pauli’s importance has not yet been realized. He has only published very short articles about philosophy before his unexpected death in 1958. Fortunately some documents of his thinking are presented in his letters, especially in his very extensive and open-minded correspondence with Markus Fierz. I shall base my lecture mainly on this correspondence which has not been published so far.

Thus, I shall first try to describe the main features of the Copenhagen interpretation on the basis of what I have learned from Pauli. Then we can try to find the points where Bohr has expressed different opinions. I hope that this will help in forming an idea of the characteristic features of the Copenhagen interpretation. I find that this term is needed even today, especially, if it is not watered down. The original Copenhagen philosophy was really revolutionary. Let us try to recollect its main ideas in the form of 10 theses.

1. When investigating microphysical phenomena, we need macrophysical instruments.
2. The operation of macrophysical instruments can be described with the aid of the everyday language which is appropriate for describing immediate sense perceptions and by using, additionally, concepts and theories of classical physics, i.e., without using microphysical concepts or theories.
3. When describing microphysical systems and events we need a new theoretical language, and when describing microphysical observations, a clear distinction has to be made between the macrophysical instrument used and the microphysical system which is the object of the observation: one has to use different languages when describing them.
4. There is a certain freedom in drawing the borderline between the measuring instrument and the object of observation, e.g., parts of the measuring instrument can be considered as microphysical and belonging to the object to be observed. In each case one must, however, clearly draw this borderline by specifying what belongs to the measuring instrument [9].
5. Each observed phenomenon has to be considered as a *whole*, describing clearly all parts of the instrument used for the observation. In general, the instrument consists of two parts: a *preparing part* and a

registrating part. The preparing part defines the situation under which objects are investigated. The registrating part produces a macrophysically observable result which is interpreted as the result of the observation [10].

6. As a result of the preparation one gets an ensemble of similar microphysical systems in the same "situation" or "state" defined by the process of preparation. This state is described by associating with *each system* the same state-function (wave-function); this function describes the state of *one system* under investigation in the situation defined by the preparation [11].

7. The state-function is a theoretical bridge between the preparation and registration. It corresponds to the conception of *causality* in macrophysics; with the aid of the state-function one can make predictions about the results of the registration. There is, however, an essential difference between the microphysical situation and the determinism characteristic of classical physics, because a certain scattering of registered results for individual systems always takes place. Therefore it is appropriate to introduce the new conception of "state" described by the state-function. This function can be interpreted as the *probability amplitude* which makes possible statistical prognoses regarding the results of registration. This is the essence of the interpretation. The deterministic causality of macrophysics has to be replaced by *statistical causality*, characteristic of the microphysical theory; with the aid of the statefunction one can only predict *mean values* in an ensemble of similar events and *mean deviations* from the mean value in individual events. In the scattering of the individual registered events, the microphysical theory contains an indeterministic element which seems to be essential and not possible to eliminate by developing the theory. Statistical causality only concerns mean values while there is a characteristic indeterminism in individual events [12].

8. The act of observation implicitly presupposes the presence of an *observer*. The observer plans the measuring instrument and interprets the results by using the theory of microphysics. All this is a result of the observer's *consciousness*, and the observation process and its interpretation only has sense for a human observer with certain sensual and intellectual abilities. Observation is always an interplay between the consciousness of the observer and the outer world. The measuring instrument can be considered as a widening of the observer's sense organs [13].

9. In order to make microphysical objects and events observable for a human observer, irreversible processes are necessary in the measuring instrument. Such processes are necessary both in the preparation and in the registration. The detailed description of these microphysical processes is not possible, only the macrophysical state of the measuring instrument before and after observation is relevant for the observation [14].

10. The microphysical theory is, in principle, a fundamental theory which also contains macrophysics as a limiting case. This *correspondence principle* by Bohr is of fundamental importance from the point of view of the unity of physics, and it has played an important role in the development of microphysics. Because the measuring instrument is always composed of microphysical systems, it is important that the behaviour of the macrophysical measuring instrument be consistent with the laws of microphysical systems [15].

In this description of the Copenhagen interpretation we have not mentioned the “quantum postulate” or “complementarity”, nor uncertainty relations. Pauli has emphasized, instead, the statistical nature of microphysical laws as the fundamental new feature of microphysics [16]. I find this more satisfying than Bohr’s or Heisenberg’s way of describing the situation. Bohr considered complementarity as a generalization of the classical, deterministic conception of causality [17]. This is a rather abstract way of describing the change in the conception of causality characteristic of microphysics, because “complementarity” is a rather diffuse concept – which does not, however, mean that it would not be important. I also find the concept of statistical causality more instructive and more general than Heisenberg’s way of emphasizing the uncertainty relations; statistical causality can be applied to phenomena where we do not know any uncertainty relations.

In fact, Pauli used the name statistical correspondence [18] instead of statistical causality. I prefer the name “statistical causality”. It concerns, at any rate, a generalized conception of causality, and therefore I find it most natural to say that deterministic causality is generalized to *statistical causality* in microphysics. What this concept means, Pauli describes in a letter to Fierz of November 19, 1949 as follows [19]:

That statistical behaviour of the many like individual systems without any mutual contact (“windowless monads”), yet without being otherwise causally determined, is regarded in quantum mechanics as the *final*, irreducible fact of lawfulness. . . . The individual systems of quantum mechanics are “windowless monads” and there is, nevertheless, always the right fraction which reacts according to calculations (apart, of course, from predicted statistical fluctuations). . . . If the fraction is 1 (instead of between 0 and 1), we do have a special borderline case in which form the old deterministic causality appears, viewed from the quantum mechanical standpoint.

On October 13, 1951 he also writes [20]:

Now comes the great crisis of the quantum of action: the individual case and its “logic” must be sacrificed in order to save an objective and rational description of phenomena. When two observers do the same, it is actually no longer the same, even in physics: only the *statistical mean values* remain generally the same. *The physical individual case can no longer be separated from the observer*, and it thus passes through the meshes of the net of physics. The individual case is *occasio* and not

causa. I am inclined to see in this *occasio* . . . a 'revenue' of the *anima mundi* suppressed in the 17th century (in another form, of course). *La donna è mobile* . . . as are the *anima mundi* and the *occasio*.

(Both translations here are made from German by Mr. J. Nichols, CERN.)

The last quotation refers to the very delicate thesis no.8. above, and will be discussed in detail in the next section. This concerns the role of the observer in quantum theory, and is the real divide in the philosophical attitudes of different thinkers.

3. The Problem of the "Detached Observer"

In the analysis of microphysical observations one cannot avoid the question of whether our knowledge of the outer world is objective. In this connection Bohr referred to the old philosophies in the Far East where the emphasis on the subject-object relations is quite different from that of Western thought. Analogously, Bohr said, in atomic physics we are not only spectators, but also actors; we influence the results of our observations.

Especially in his complementarity idea Bohr found connections with Eastern thought. This was emphasized in Bohr's coat of arms in the Danish Elephant Order where Bohr used the Chinese Yin-Yang symbol. When speaking of these analogies, Bohr, however, used to remark that science cannot be intermixed with any kind of mysticism.

As an example of Bohr's thought, a passage from his article "Biologie und Atomphysik" (1938) may be quoted here [21]:

The whole set of concepts of classical physics, which has achieved such a wonderful unity and completeness through Einstein's work, is based on the presupposition, so well motivated in our everyday experience of physical phenomena, that it is possible to make a distinction between the behaviour of material bodies and their observation. When searching for an analogy to the lesson which atomic theory has given to us with respect to the limited validity of such general idealizations, we have to turn to such branches of natural science, far away from physics, as, e.g., psychology or even to return to those epistemological problems which such great thinkers as Buddha and Lao-Tse met, when they attempted to find an expression for the harmony in the great drama of existence, where we simultaneously are actors and spectators. The knowledge of such an analogy in the purely conceptual character of problems which we meet in so different fields of research, may not, however, be confused with an introduction of mysticism alien to the very spirit of science.

Pauli gave very much thought to these problems, and did not share Bohr's aversion to mysticism. On the contrary, he found it impossible to draw a clear borderline between scientific and religious thought. Those problems concerning the very foundations of science which seem to have frightened Bohr, Pauli took very seriously, and he found in this connection the necessity of making a careful study of Eastern and Western mysticism, epis-

temological attitudes of different thinkers, and especially psychology. His final opinion was that we have to abandon the idea of “realism” in the sense in which this word is used today. According to his opinion, the most important lesson that quantum mechanics has given us is, that *we must always include the observer in our picture of the world*. This was the original spirit in the Copenhagen philosophy, and exactly in this decisive point Pauli represents this philosophy in the most consistent way.

In the discussions between Bohr and Pauli, this problem is called the question of the *detached observer*. At question is whether it is possible to speak of the objective existence of the atomic world, in principle “cutting off” the observer. Bohr was always somewhat hesitant concerning this problem and in the fifties he clearly changed his expressions somewhat when describing the epistemology [22] of it. I have understood this formally small but factually very important change in his expressions to be the result of philosophical criticism.

Important was perhaps Academician V. Fock’s visit to Copenhagen in the spring 1957. At that time the Copenhagen philosophy was considered as unacceptable in the Soviet Union, and some physicists had found themselves in difficulties because of their opinions in the interpretation of quantum mechanics. Fock’s remarks to Bohr are filed in the Niels Bohr Archive in Copenhagen. They are also mentioned in Fock’s article in the *Uspekhi Fiz. Nauk* in 1958 [23]. The essential point is that one should avoid giving the impression that our knowledge about atomic systems might not be objective. Fock also stressed that the state-function is not only symbolic, describing only our knowledge about the system, but is an element of the physical reality.

In his article “Quantum Physics and Philosophy. Complementarity and Causality”, published in 1958, Bohr slightly changed his expressions, and, because of this, Fock could state that Bohr was coming closer to the materialistic interpretation of quantum mechanics. Fock also translated Bohr’s article into Russian and it was published in the next issue of *Uspekhi* (January 1959).

After this, there was a clear discrepancy between Bohr’s and Pauli’s conceptions of reality. Pauli has not mentioned this difference in any publications, and since he died in 1958 people do not know now, what the Copenhagen philosophy really entails. It is considered to be positivistic, and Bohr’s hesitation in his expressions concerning reality strengthens this opinion. Bohr’s assistant, Dr. Aage Petersen described Bohr’s conception of reality as follows [25]:

When asked whether the algorithm of quantum mechanics could be considered as somehow mirroring an underlying quantum world, Bohr could answer, “There is no quantum world. There is only an abstract quantum physical description. It is wrong to think that the task of physics is to find out how nature *is*. Physics concerns what we can say about nature.”

I am not quite sure that this is exactly what Bohr would say, but in fact people generally think that the Copenhagen philosophy is positivistic or instrumentalistic, which is understandable as Bohr was not willing to discuss the question of reality.

For Pauli, the description of reality was the central task of science. Therefore he studied ontological and epistemological ideas very carefully, as well as their development through the ages, Eastern philosophies included.

The difference in the characteristic question of the detached observer, between Bohr and Pauli, can best be seen from Pauli's letter to Bohr of February 15, 1955 [26]. Bohr had sent the manuscript he was working on for his article "Unity of Knowledge" [27] to Pauli for criticism. This manuscript was based on his lecture given in connection with the bicentennial of Columbia University, N.Y. Pauli writes:

Dear Bohr,

It is with great pleasure that I received your nice letter and above all, the text of your lecture on "Unity of Knowledge". The general outlook of it is of course the same as mine. Under your great influence it was indeed getting more and more difficult for me to find something on which I have a different opinion than you. To a certain extent I am therefore glad, that eventually I found something: the definition and the use of the expression "detached observer", which appears on page 10 above of your lecture and which reappears on page 13 in connection with biology. According to my own point of view the degree of this "detachment" is gradually lessened in our theoretical explanation of nature and I am expecting further steps in this direction.

1) As you will see in the reprint on my lecture on "Probability and physics", which I have sent to you, it seems to me quite appropriate to call the conceptual description of nature in classical physics, which Einstein so emphatically wishes to retrain, "the ideal of the detached observer". To put it drastically the observer has according to this ideal to disappear entirely in a discrete manner as hidden spectator, never as actor, nature being left alone in a predetermined course of events, independent of the way in which the phenomena are observed. "Like the moon has a definite position" Einstein said to me last winter, "whether or not we look at the moon, the same must also hold for the atomic objects, as there is no sharp distinction possible between these and macroscopic objects.

Observation cannot *create* an element of reality like a position, there must be something contained in the complete description of physical reality which corresponds to the *possibility* of observing a position, already before the observation has been actually made." I hope, that I quoted Einstein correctly; it is always difficult to quote somebody out of memory with whom one does not agree. It is precisely this kind of postulate which I call the ideal of the detached observer.

In quantum mechanics, on the contrary, an observation *hic et nunc* changes in general the "state" of the observed system, in a way not contained in the mathematically formulated *laws*, which only apply to the

automatical time dependence of the state of a *closed* system. I think here on the passage to a new phenomenon by observation which is taken into account by the so-called “reduction of the wave packets”. As it is allowed to consider the instruments of observation as a kind of prolongation of the sense organs of the observer, I consider the unpredictable change of the state by a single observation – in spite of the objective character of the results of every observation and notwithstanding the statistical laws for the frequencies of repeated observation under equal conditions – to be *an abandonment of the idea of the isolation (detachment) of the observer from the course of physical events outside himself*.

To put it in nontechnical common language one can compare the role of the observer in quantum theory with that of a person, who by its freely chosen experimental arrangements and recordings brings forth a considerable “trouble” in nature, without being able to influence its unpredictable outcome and results which afterwards can be objectively checked by everyone.

Probably you mean by “our position as detached observers” something entirely different than I do, as for me this new relation of the observer to the course of physical events is entirely *identical* with the fact, that “our situation as regards objective description in this field of experience” gave rise to the demand “of a renewed revision of the foundation for the unambiguous use of our elementary concepts”, logically expressed by the notation of complementarity.

Part 2) concerns biology and must be omitted here.

In spite of Pauli’s criticism, Bohr did not change his remark about the “detachment” of the observer. Obviously he had decided to avoid “unnecessary” conflicts in this respect. Pauli was quite aware of the difficulties and dangers which follow from denying the objectivity of our knowledge. He, however, understood that we cannot close our eyes to something only because we are not willing to see it or fear it. The study of the foundations of quantum mechanics thus led him to a conception of reality which seems to be quite unknown to people who nowadays call themselves “realists”: Pauli accepted the irrationality of the outer world.

4. Pauli’s Philosophical Attitude

In spite of this, Pauli must be called a realist. He often emphasized the importance of searching for a conception of reality which would correspond to our present theories. For instance, in the letter to Fierz on August 12, 1948 [28] he writes:

This problem [the question of the picture of God] is very closely related to the other problem of the idea of *reality*. When he speaks of “reality”, the layman usually means something obvious and well-known, whereas I think that the important and extremely difficult task of our time is to

try to build up a fresh idea of reality. This is also what I mean when I continuously stress that science and religion *must* be connected in some way. . . . I could call what I feel by the new idea of reality, by way of trial, *the idea of the reality of symbol*.

Today "realism" normally means that one tries to rescue, in some way, the objectivity of the outer world, in spite of the observation problems we have encountered in atomic physics. "Realism" is then strongly influenced by empiricism which has a strong tradition, especially in the Anglo-Saxon world and in natural science. Nobody seems to think of psychological problems of observation and of such deep changes which Pauli found necessary. I would like to say: nobody has time for that because people have to publish.

It is not possible to describe, in this connection, Pauli's philosophical attitude in detail. I must refer to my (not quite finished) manuscript "Jenseits der Atome" [29] which will be available in our small "Pauli Library" during the Symposium. When comparing Pauli's thought with some traditional main streams in philosophy, I would like to say the following:

Pauli was certainly *not any positivist or instrumentalist*. This he emphasizes in several letters. He was a *realist*. But he found that atomic physics forces us to change our conception of reality in a very drastic way. First of all, we must understand that there is an *irrational element in reality*. (Perhaps one could speak of irrational dimensions.) Only statistical mean values can be described in a rational way, individual events "pass through the meshes of the net of rationality".

For Pauli *platonism* – or pythagoreanism – was very attractive. He believed in the important role of logic and mathematics in the description of reality. Statistical causality shows, however, that we should not overestimate these possibilities. Pauli came to the conclusion that a rational picture of the world can never grasp the whole of reality. Therefore, at the end, Pauli was *not a platonist*.

The same is true of *cartesianism*. It also presupposes that reality can, in full, be grasped by rational thinking. In addition, characteristic of the philosophy of Descartes was the dualism of spirit and matter. This dualism was understandable and even important in the 17th century, but we must now realize that Western culture went too far in the 17th century in this respect. Therefore Pauli was *not any cartesianist either*.

Empiricism has been a very strong tradition among natural scientists. Pauli, however, found this attitude to be rather superficial. Empirical data do not give any information of reality itself, they only present some features of reality *after the preparatory work of the human psyche*. Our unconscious psyche treats, instinctively, the sensory perceptions we receive, in a typically human way. We see shapes (Gestalt) which are produced by the processes in our unconscious psyche. It also steers our thinking when constructing concepts or theories. Therefore we should not rely too much on the empirical facts. Our picture of the world is always a human picture of the world, and we should not forget the role of our own psyche in the observation processes.

Empiricism very easily results in *materialism* where spirit is considered only a secondary product of material processes. Empirical science has, in fact, strengthened materialism enormously. More and more people think that they can avoid cartesian dualism by simply omitting the spirit as an unnecessary hypothesis. This attitude Pauli found to be extremely dangerous. The one-sided emphasis put on the material side of reality steers our culture into a dangerous direction which can only end in a catastrophe, because one has neglected an essential part of reality. Pauli found *materialistic philosophy to be very dangerous. But neither was he an idealist. A balanced conjunction of spirit and matter was the aim.* The idea of complementary opposites and their conjunction was characteristic of Pauli's thinking.

I would like to say that Pauli was the most competent representative of the Copenhagen philosophy. This philosophy does not correspond to the way of thought in any of the traditional philosophies. It has been developed in close contact with empirical research. Therefore, nature itself has guided physicists to this new way. If we think of the Copenhagen philosophy in its original unchanged form this is really a revolutionary philosophy. It opens up a new perspective to the comprehension of reality – a complementary perspective. There are severe obstacles in the way of accepting this philosophy, both in the West and the East, but I believe that it is a philosophy of the future.

I also believe that Pauli will be found to be a much greater philosopher than people think today.

Addendum: Remark on the EPR-Problem

In the discussion section of the Pauli Seminar, the author tried to describe the EPR-situation from the point of view of Pauli's thought as follows:

Think of a system S consisting of two parts, I and II, which then fly apart. This system S forms a whole which can be described with the aid of a certain state-function, until an observation concerning one part, say I, is made. On the basis of the state-function we can make certain predictions concerning the part II which is far away. After the observation we do not have the system S any more but, instead, two systems I and II in certain states for which state-functions can be given on the basis of the observation concerning the part I; in fact, part I has been used for registration, and only the state-function of part II is available for predictions.

Since we can freely choose the method of observation concerning part I, we "interact" with the system S in a way which partly depends on our will, partly is indeterminate. The result is that we create two new systems I and II in certain states. In this *creation process* the spatial distance of parts I and II is not essential. A more detailed description of this process than quantum mechanics gives is not possible; it cannot be described with the aid of any causal chains but it contains an "irrational influence" which is independent of space and time.

Pauli emphasized that in quantum mechanics we do not only function “natura naturata” (as created nature) but also can function “natura naturans” (as creating nature) which means “influences” independent of space and time. This is due to the irrational features of reality¹. It is in this sense that I also understand the EPR situation. Attempts to make this irrationality disappear, by using some kind of logical analysis of the situation, are in vain – they are attempts in a wrong direction, as Pauli often used to say.

¹See, e.g. PLC 0092.138, p.144 ff.

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- 2 An interesting description of the creation period of quantum mechanics is recently given by John Hendry: *The Creation of Quantum Mechanics and the Bohr–Pauli Dialogue* (D.Reidel, Dordrecht, 1984)
- 3 Wolfgang Pauli: Wissenschaftlicher Briefwechsel¹ I, eds. A. Hermann, K. v. Meyenn, and V.F. Weisskopf (Springer, New York, 1979) item [74], pp. 188–189
- 4 W. Heisenberg: Über quantentheoretische Umdeutung kinematischer und mechanischer Beziehungen. *Z. Phys.* **33** (1925) pp. 879–893
- 5 PWB I, item [143], pp. 346–347
- 6 See Hendry, *ibid.*, Chaps. 7–9
- 7 W. Heisenberg: Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik. *Z. Phys.* **43** (1927) pp. 172–198
- 8 See, e.g., PWB I, items [163], [164], [165], and [167], and Hendry, *ibid.*, Chap. 9. Also M. Jammer: *The Philosophy of Quantum Mechanics* (Wiley, New York, 1974) p. 68
- 9 The “theses” 1–4 correspond to the description of the observation problem in Bohr’s article “Discussion with Einstein . . .” in Albert Einstein: *Philosopher – Scientist*, ed. P.A. Schilp (Tudor, New York, 1949) pp. 209–211
- 10 The *wholeness* of a phenomenon in quantum physics has been emphasized by Bohr, especially, in his article in *Dialectica* **2**, No 3/4 (1948). This issue was edited by Pauli and dedicated to the concept of complementarity. Cf. also Bohr, *ibid.*, p. 222 and p. 230
- 11 In the “ensemble interpretation” the state–function is associated with an ensemble of similar atomic systems prepared in the same way. This interpretation is, however, unable to describe individual events because it always presupposes a large ensemble of events. The irrationality of reality which Pauli emphasizes is, therefore, *a priori* made to disappear! Thus, this interpretation should not be mixed with the original “statistical interpretation” which associates the state–function with one individual system; an ensemble is then needed only in the verification of theoretical predictions

¹In short: PWB

- 12 In his Editorial to the *Dialectica* issue on complementarity (ref. 10) Pauli emphasizes the idea of statistical causality as the most characteristic idea of quantum mechanics. See also ref. 18
- 13 The role of the observer is discussed in Sect. 3. Pauli's view is presented in his letter to Bohr cited there (ref. 26)
- 14 "Thesis 9" will not be discussed in this article. It implicitly contains the "quantum postulate" or the "indivisibility" ("individuality") of quantum phenomena
- 15 The discussions of the correspondence principle are also omitted here. It is only mentioned as an essential element in the Copenhagen interpretation
- 16 See ref. 12 and ref. 18
- 17 See, e.g., Bohr, *ibid.*, p. 211. More about complementarity as a generalized causality in ref. 24
- 18 W. Pauli: Die philosophische Bedeutung der Idee der Komplementarität *Experientia* VI/2 (1950) Sect. 3. W. Pauli: Wahrscheinlichkeit und Physik. *Dialectica* 8/2 (1954). See also the letters to Fierz PLC² 0092.063 and PLC 0092.066; the first one is published in K.V. Laurikainen: Wolfgang Pauli and Philosophy. *Gesnerus* 41 (1984) pp. 225–227
- 19 Letter PLC 0092.063 mentioned in ref. 18
- 20 Letter 0092.078, published in K.V. Laurikainen, *ibid.*, p. 230
- 21 N. Bohr: *Atomphysik und menschliche Erkenntnis* (Vieweg, Braunschweig 1958; "Facetten der Physik") p. 18³
- 22 This change is also emphasized in K. Baumann & R.U. Sexl: *Die Deutungen der Quantentheorie* (Vieweg, Braunschweig, 1984) Teil 1, Kap.10
- 23 V.A. Fock: Some Remarks Concerning Bohr's Article on his Discussions with Einstein (private translation by V.A. Fock for N. Bohr), *Usp. Fiz. Nauk* 66 (1958) pp. 599–602. Translation filed in the Niels Bohr Archive in Copenhagen
- 24 N. Bohr: Quantum Physics and Philosophy. Causality and Complementarity. *Philosophy in the Mid-Century*, ed. R. Klibansky (La Nuova Italia Editrice, Florence, 1958)
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- 26 Letter PLC 0014.51. Letter is published with the permission of the assignees
- 27 N. Bohr: Unity of Knowledge. *The Unity of Knowledge*, ed. L. Leary (Doubleday, New York, 1955)
- 28 Letter PLC 0092.052, published in K.V. Laurikainen, *ibid.*, p. 222
- 29 K.V. Laurikainen: *Jenseits der Atome*. Gedanken von Wolfgang Pauli über Geist und Materie, über die Natur der Wirklichkeit und über die Rolle des Bösen in der Welt. (In Finnish: Kirjapaja, Helsinki, 1985; in German publisher not decided)

² Pauli Letter Collection, CERN, Geneva; in short: PLC

³ The text corresponds to a lecture given in 1937

The Role of the Observer in Microphysics *

The basic nature of the microworld of atoms and elementary particles seems to increasingly interest people today, though not so much physicists as those outside physics. The majority of physicists are quite satisfied with the philosophy which the *Copenhagen interpretation of quantum mechanics* represents.

Quantum mechanics is the theoretical key to the microworld. It was created 60 years ago, but it still contains deep epistemological and ontological problems. In fact, it is only now that people have begun to understand that this theory can change our basic beliefs and ideologies as much as nuclear technology has influenced politics.

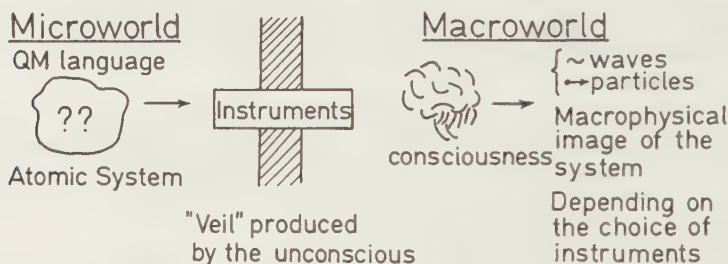
The dominating philosophy among physicists corresponds closest to Bohr's thought. His assistant Aage Petersen has described it as follows [1]: "There is no quantum world. There is only an abstract quantum physical description. It is wrong to think that the task of physics is to find out how nature *is*. Physics concerns what we can say about nature." I would like to say that this sounds a little too positivistic or instrumentalistic. Bohr never wished to deny the reality of the outer world. He only found that it is extremely difficult to find a satisfactory description for the basic nature of the microworld by using the natural language. Therefore he wished to avoid philosophical preconditions and to concentrate instead on the description of microsystems in association with experimental results. This should not be interpreted as an antirealism as indeed many people do.

The general trend in ontology after World War II has been towards "realism", but opinions differ rather much if one must declare in more detail what "realism" means. A general basic view is a conception of an objective universe which exists independent of human observers. In microphysics this view becomes problematic because the act of observation has an influence on the results of the observation. For this reason Bohr introduced the concept of *complementarity*. Many philosophers in particular have not been satisfied with this concept, and the discussion concerning the nature of "quantum reality" has not at all resulted in an unambiguous picture of the microworld.

*Lecture in Baden-Baden on August 22, 1986 at the 3rd International Conference on Systems Research, Informatics and Cybernetics. Published in the Preprint Series in Theoretical Physics, University of Helsinki HU-TFT-86-41, pp. 1-10.

The crucial question is *whether it is possible in microphysics to speak of objects which exist and have certain properties independent of observation*. We are accustomed to thinking that reality consists of such more or less invariant objects. In microphysics, however, the existence of such “objects” is not clear because microphysical “objects” reveal quite different and even contradictory properties in different experiments.

It is, in fact, astonishing that psychological problems concerning observation have not played a more essential role in this discussion. Since Descartes and Kant people seem to think that the “inner world” does not have anything to do with physical reality. The aim of my talk is to emphasize the role of the human psyche when forming a picture of the microworld.



Microworld and Psyche

According to Heisenberg we must think of the microworld as consisting of two different levels: 1) the level of *potentialities* which is independent of observation and 2) the level of *actualities* which we can attain in our observations. The quantum mechanical formalism and particularly its wave functions describe the level of potentialities. The wave-function of an atomic system normally consists of an infinite number of wave components each of which represents a potential state of the system. When an observation takes place, it leads to the famous “collapse (reduction) of the wave-function”: according to the result of the observation we know that the system is in a definite state, and so one of the potential states represented by the initial wave-function *actualizes* in the observation.

Furthermore, the initial wave-function describes not only the system but also its *neighbourhood* which determines the boundary conditions for the solution of the Schrödinger equation to be used in this situation. When the observer chooses the method of observation, he must also find the correct solution for the Schrödinger equation which then describes the system in the given neighbourhood. It contains, as its different component waves, the potential states which can be actualized when using this experimental arrangement.

Just which of these potential states will be actualized cannot be predicted; one can only give probabilities for different possible states. This is the famous *acausality* of the microworld which many people, such as Einstein

for instance, have interpreted as an indication of the *incompleteness* of quantum mechanics. According to the Copenhagen philosophy, however, *there is no "more complete" reality*. There is just a *potential level* of reality where "objects" do not have definite attributes. Only in the act of observation do microphysical "objects" receive certain attributes, and by choosing the method of observation the observer has an effect on the attributes which the "objects" receive.

Heisenberg interprets the wave-function as a description of *the observer's knowledge* of the system. The initial wave-function only contains knowledge of different "potentialities". According to this interpretation there is nothing "paradoxical" or "mysterious" in the notorious "collapse of the wave-function": as a result of the observation *our knowledge of the system is changed*, and therefore the wave-function "collapses".

This interpretation of the wave-function as describing the knowledge of the observer, however, presupposes that we introduce a fundamentally new element into the discussion: the *consciousness of the observer*. Physicists and philosophers who are not willing to introduce psychic elements into physics cannot accept this interpretation. They understand the wave-function to be an element of physical reality, not merely descriptive of the knowledge of a conscious observer. Especially for Heisenberg and Pauli, however, the wave-function explicitly referred to the observer's knowledge, and they saw an observation as an interaction between the material object and the consciousness of the observer (in the situation which the experimental arrangement defines). An observation is always an interaction between the material "outer world" and the spiritual "inner world". *Reality is a whole consisting of these two parts which can influence one another*.

Bohr was in this respect more hesitant, probably due to the criticism of the philosophers. In the fifties he clearly accepted the idea of a "detached observer" which means that an observation can always be arranged so that the observer does not influence the results [2]. This is in clear contradiction to a view which he has emphasized very much and which he has expressed by stating that "in the great drama of existence we are simultaneously actors and spectators" [3]. Bohr's acceptance of the idea of a "detached observer" in the fifties, in fact, means that he adopted the materialistic attitude with respect to the ontology of physics, excluding the possibility of psychic influences on the material world.

Both Heisenberg and Pauli, instead, have emphasized that it is necessary to reject cartesian dualism and to reconsider the role of our psyche in forming our conception of reality. Pauli wrote (e.g., [4]) that *the psycho-physical problem is the most important question of our time*. Analogously, Heisenberg stated in his "Physics and Philosophy" ([5], p.75);

"If one follows the great difficulty which even eminent scientists like Einstein had in understanding and accepting the Copenhagen interpretation of quantum theory, one can trace the roots of this difficulty to the cartesian partition. This partition has penetrated deeply into the human mind during the three centuries following Descartes and it will take a

long time for it to be replaced by a really different attitude toward the problem of reality.”

The remarks in this lecture concerning the Copenhagen philosophy are mainly based on Pauli's thought. In philosophical questions Pauli is the clearest representative of the Copenhagen group. The most important source in this respect has, for me, been the unpublished Pauli-Fierz correspondence from the last ten years of Pauli's life [6]. Because sufficiently long quotations from this unpublished correspondence are not allowed, *I must describe Pauli's views in my own words and as I have understood them.*

The new element which Pauli brought into the discussion concerning reality is the influence of the *unconscious psyche*. Here Pauli's close contact with the Swiss psychiatrist C.G. Jung has influenced Pauli's thought. This is a point where Pauli's views clearly differ from both Bohr's and Heisenberg's thought. With respect to Bohr, Pauli explicitly states that he has never understood the nature of the unconscious and its influence on our thinking [7].

Focusing attention on the unconscious sheds new light on the “paradoxes” of the Copenhagen interpretation. They begin to appear as necessary expressions of the fact that our rational knowledge rests on the irrational depths of the unconscious.

The Problem of Two Languages

The need for *two languages* is an essential feature of the Copenhagen interpretation. Our natural everyday language is an indispensable means of communication and, therefore, the basis of all objective knowledge. One cannot discard it in atomic physics either. In particular, the experimental arrangements and the results or experiments are described by using natural language or its scientific enlargements in classical physics. When describing microphenomena, however, a new language has been found to be necessary: the quantum mechanical language which includes a certain mathematical formalism and its association with experimental results with the aid of a particular interpretation. The relation of the new language to the natural one has been a problem especially for philosophers who have learned to be very careful with respect to the intermixing of different languages.

In microphysics we cannot speak of “objects which have definite properties (attributes)” *because the properties of an “object” depend on our method of observation.* It is exactly this new relation of object to observation which can be illuminated by considering the *activity of the unconscious.*

In our immediate perceptions we comprehend the world in the form of certain “objects” (“things”) presupposing that these “objects” have certain attributes which are “objective”, i.e., independent of observation. This picture of more or less invariant “objects” is the basis of our knowledge and also the basis of the description of the changes of these “objects”. Before this immediate picture of the world is formed, our unconscious psyche has instinctively done an enormous amount of preparatory work. An observer

with different sensory abilities and with a different intellect (an insect, for instance) would certainly comprehend the same neighbourhood in a different way. The world which we perceive is not the same as "reality itself", neither is it an unambiguous result of the sensory stimuli we receive from the "outer world". It is characteristic of the human picture of the world that we *comprehend it as composed of objects which can be identified with the aid of certain attributes, in a more or less invariant and objective manner.*

This kind of picture of the world, produced by the activity of our unconscious psyche, is the basis of natural language, and it makes the objective knowledge of the "outer world" possible. In the scientist's attempts at forming a more detailed picture of the world he tries to maintain this basic structure of reality. Only in atomic physics has one, thus far, met difficulties, and for this reason a new language based on a different picture of the world has been necessary.

The need for two languages is understandable in a field where we must investigate phenomena which are very far from the range of our immediate perceptions. Conceptions characteristic of the functioning of our unconscious may then lead us astray. This especially concerns the concepts of *space, time, and causality*. According to Kant these concepts are given to us *a priori* in the sense that they are *products of our psyche*: they are characteristic of the human way of comprehending the world. This view is also close to that of Eastern philosophies. In modern physics the concepts of space, time and causality have undergone essential changes, first in the theory of relativity and later in atomic physics. For this reason Kant's view of the *a priori* nature of these concepts was too narrow, but even in modern physics space, time and causality are central concepts which we cannot dispense of, and they seem to be characteristic of human knowledge in general. A change in these concepts shakes the foundations of the whole picture of the world.

In all cases where some field of reality very far from our immediate perceptions is investigated, a similar need for two languages may appear. It is not any "paradox", it is understandable if science tries to penetrate very deeply into such fields of reality where the instinctive patterns of recognition (Gestalt) cannot be used. In such cases it is necessary to carefully reconsider the relation between the "outer world" and the "inner world", i.e., the psycho-physical problem, because some basic features of our knowledge as creations of the activity of our unconscious psyche may have to be changed in such a situation.

The "intermixing" of two languages is not justified, of course, if these languages are incompatible with one other. In quantum theory this compatibility is guaranteed with the aid of Bohr's correspondence principle: quantum mechanical theory is constructed such that it reduces to classical mechanics in the limiting cases when typical quantum effects are negligible (formally, when $h \rightarrow 0$). This is a very important principle which has played an essential role in the creation of quantum mechanics. On the basis of this principle, quantum mechanics is a *generalization* of classical mechanics,

containing it as a special limiting case. This also guarantees that the new quantum mechanical language be compatible with the language of classical mechanics and, a fortiori, with our natural language. If the role of the correspondence principle in physics is correctly understood, the concern of some philosophers over the “intermixing” of languages appears unwarranted.

The Role of the Experimental Arrangement in Observation

In the criticism concerning the “intermixing of languages” in the Copenhagen interpretation, one essential argument is that experimental equipment should be described by using the quantum mechanical language, instead of our natural language, because it is composed of atomic systems. This argument can be understood from a materialistic-monistic point of view, because the whole world must according to this view be described on the same basis, including the observer’s psyche.

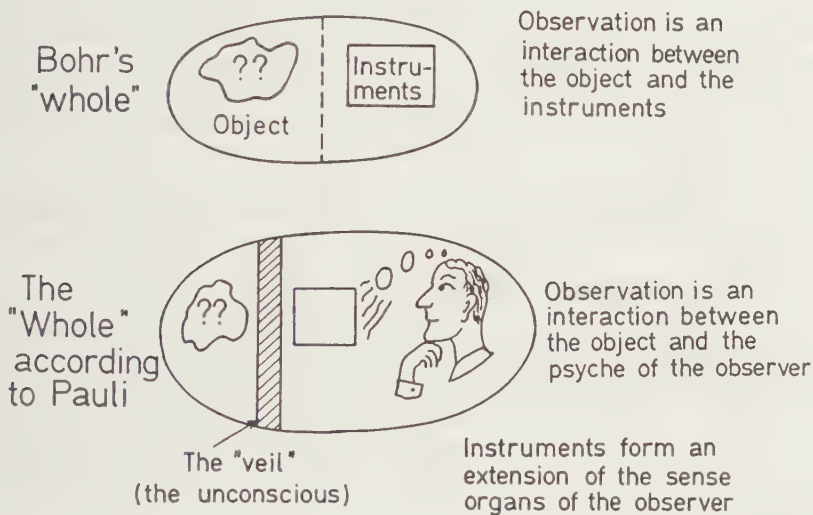
In the Copenhagen philosophy the role of the experimental arrangement is, however, quite different. It belongs explicitly to the *macrophysical level* from which we get our immediate perceptions. This can perhaps best be illustrated by quoting a passage from Pauli’s letter to Bohr of February 15, 1955 [8], in which Pauli describes the nature of microphysical observations:

“In quantum mechanics, on the contrary, an observation *hic et nunc* changes in general the “state” of the observed system, in a way not contained in the mathematically formulated *laws*, which only apply to the automatic time dependence of the state of a *closed system*. I think here on the passage to a new phenomenon by observation which is technically taken into account by the so-called “reduction of the wave packets”. As it is allowed to consider the instruments of observation as a kind of prolongation of the sense organs of the observer, I consider the unpredictable change of the state by a single observation – in spite of the objective character of the results of every observation and notwithstanding the statistical laws for the frequencies of repeated observation under equal conditions – to be an *abandonment of the idea of the isolation (detachment) of the observer from the course of physical events outside himself*.”

In this letter Pauli criticizes Bohr’s acceptance of the idea of a “detached observer” in atomic physics. Pauli wishes to point out that an observer always influences the “outer world” if he gets any knowledge through his observation. Therefore the observer is never “detached”, he is not only a spectator but simultaneously also an actor. In this respect Bohr’s view became unclear during the fifties [9].

Most important from the point of view of our present problem is Pauli’s description of “*the instruments of observation as a kind of prolongation of the sense organs of the observer*”. This corresponds precisely to the basic philosophy of the Copenhagen interpretation. A measuring device is a

tool for getting certain sensory perceptions, and the description of its functioning as composed of atomic particles would be “out of place”. It is, of course, possible to investigate the functioning of the device from this point of view also, but a separate problem is that of the use of the device as a tool for investigating an atomic system outside it. In the last case the piece of equipment is not considered a complicated system of atomic particles but a “prolongation of the sense organs of the observer”. If we understand an observation to be an interaction between the psyche of the observer and the “outer world”, the instruments of observation must be considered as belonging to the macrophysical level from which we get certain perceptions of the outer world.



In light of such considerations many attempts at fashioning a more detailed description of the measuring process must be regarded as “attempts in a wrong direction”, as Pauli used to say in such cases. This applies to the so-called theory of measurements.

The Struggle for Wholeness in Atomic Physics

In his later years Bohr used to strongly emphasize the *wholeness of the observation*. This meant that it is always necessary to take into account the whole experimental arrangement, including everything that can have an influence on the results of observation. The whole experimental arrangement determines the boundary conditions for the process which always concerns the behaviour of a given atomic system in the neighbourhood determined by the interaction between the object of observation (the atomic system) and its neighbourhood, and, together forming, according to Bohr, *the whole* which has to be taken into account.

Pauli found this struggle for wholeness (*Ganzheitsstreben*) by Bohr to be extremely important for the understanding of the observation process. He was not, however, satisfied with the way Bohr spoke of this “wholeness”. Bohr spoke only of the interaction between the atomic system and the instruments of observation, while Pauli considered the observation to be an interaction between the atomic system and the *consciousness of the observer*. This is a fundamental difference. Bohr accepted a purely materialistic view while Pauli emphasized here an interaction between matter and *psyche*. When Pauli spoke of the complementarity of physics and psychology, it had a deep significance for him while Bohr’s remarks concerning psychology were much more superficial.

Pauli’s view of observation brings the “struggle for wholeness” to an end and opens very deep perspectives on the psycho-physical problem. Once again, it is essential to remember that the “psyche” of the observer includes not only his consciousness but his unconscious as well. In this way the observation process attains *irrational* aspects and, as I see that only in this way does the basic philosophy of the Copenhagen interpretation become truly understandable.

As a philosopher, Pauli was deeper than Bohr, and his knowledge of psychology was more complete – very much due to his close contact with C.G. Jung.

Time does not allow a more detailed description here of these manyfaced relationships. I shall expand on them elsewhere [10]. The most essential result of these considerations is that *reality must be understood as a whole containing both physical and psychic aspects!* Matter and psyche are complementary expressions of reality and have a continuous influence on one another. This is a complementary alternative to cartesian dualism.

The complementary conception of reality has a more general interest, having important implications in many fields outside physics, but they do not belong to the realm of this lecture.

References

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- 2 Niels Bohr: *Atomphysik und menschliche Erkenntnis* (Vieweg & Sohn, Braunschweig, 1958) p. 75
- 3 E.g., item, pp. 19–20. (This lecture was given in 1937)
- 4 *Pauli Letter Collection* (= PLC) in CERN, Geneva, e.g., no. 0092.078 and no. 0092.092
- 5 Werner Heisenberg: *Physics and Philosophy* (George Allen & Unwin Ltd., London, 1959; third impression 1971)
- 6 The Pauli–Fierz Correspondence in PLC (cf. ref. 4)
- 7 PLC, no. 0092.054; Letter to Fierz of November 3, 1948
- 8 PLC, no. 0014.51; Letter to Bohr of February 15, 1955. This letter is also quoted in Henry J. Folse: *The Philosophy of Niels Bohr* (North-Holland, Amsterdam, 1985)

- 9 With respect to the change in Bohr's expressions in the fifties, see, e.g., K. Baumann & R.U. Sexl: *Die Deutungen der Quantentheorie* (Vieweg, Braunschweig, 1984) Teil 1, Kap. 10, and also K.V. Laurikainen: Wolfgang Pauli and the Copenhagen Philosophy; *Symposium on the Foundations of Modern Physics*, eds. Pekka Lahti and Peter Mittelstaedt (World Scientific Publ. Co., Singapore, 1985); included in this volume as Appendix I
- 10 Main features of Pauli's philosophical thought have been described in Finnish in the book K.V. Laurikainen: *Atomien tuolla puolen* (Kirjapaja, Helsinki, 1985)

The Possibility of Science and Its Limits *

*The most incomprehensible thing about the
world is that it is comprehensible.*

Einstein

Every researcher who aspires to form for himself a picture of the nature and reliability of human knowledge encounters the mystery which Einstein has dressed in the aforementioned aphorism. Knowledge presupposes concepts and an understanding of the relations between them, i.e., the operation of the intellect. What grounds are there for saying that the constructs of the intellect actually correspond to the structure of the world? This is a fundamental question concerning man's knowledge, to which the reason can supply no answer. Einstein referred to it as a great mystery which was the starting point of his religious views. He often spoke about "the Old One" whose depth of understanding made the researcher marvel.

This mystery appears especially pronounced in the mathematical natural sciences, which are also empirical sciences. Mathematics is a creation of man's intellect, but even so it applies to the description of nature amazingly well. It is not a merely passive aid for the researcher, but rather, in a remarkable way directs him to the right path. The basic structure of reality is mathematical, and man's thought reflects this mathematical structure of reality. This is an empirical fact, but what is it based on?

Christianity contains an idea which is related to this mystery: man is created in the image of God. If we believe that God reveals himself to us also in nature – a question which protestant theology is quite hesitant in taking a stand towards – then this thought gives us one answer to this mystery. The structure of the world and the structure of man's intellect reflect God's thoughts. That is an answer built on a foundation of faith.

Another expression of faith is found in the "reflection theory" of dialectic materialism. According to this, man's psyche is a product of matter and reflects its properties.

The philosophy of Antiquity and of the Middle Ages also contains a response of faith. It spoke of a correspondence which reigned between the microcosm (man) and the macrocosm.

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These are all answers of faith. It now appears that the research into the foundations of atomic theory and the new currents of psychology may throw new light upon this age-old problem.

Archetypes

Psychology here refers to C.G. Jung's "Depth Psychology" where the influence of the psyche's unconscious level upon thought is emphasized. The concept of the "archetype" is frequently used here. The roots of this concept extend back into the past.

In my article "Tieteen Metafyysiset Juuret" (The Metaphysical Roots of Science, *Arkhimedes* 1/1985, Helsinki), I have described the change in the nature of knowledge and in the conception of reality which was associated with the development of the empirical method at the beginning of the new age. The idea of a spiritual basis of the world was superseded at that time by the new conception of causality. The world was considered – particularly in Neo-Platonism – as a huge organism which in its functioning was directed by the anima mundi, the world soul. This idea was brushed aside surprisingly quickly once it was learned how to describe phenomena according to mathematical laws.

Raimo Lehti, in the 2/1985 issue of the *Arkhimedes*, has described the confidence in the possibility of a mathematical description of phenomena, which was the cornerstone of the new natural science (he limits the discussion to Galileo, but the matter is more general). This is precisely what is meant by adopting the new concept of causality: it was believed that phenomena were ruled by exact mathematical laws, the validity of which could be empirically verified.

When the new research methods displayed their great strength, the idea of a spiritual background behind these occurrences was forgotten. A mechanical world-view was born: the world was no longer conceived of as a great organism, but rather, as a huge machine which operated according to "great, eternal, iron laws".

In his *Depth Psychology*, C.G. Jung returned to certain ideas which were pushed aside by the growing domination of the new natural sciences. It is interesting that Wolfgang Pauli ended up with a similar view in atomic theory. The common work of Jung and Pauli, "Naturerklärung und Psyche" (Rascher Verlag, Zürich, 1952), is an expression of the parallel direction of their thought. It consists of two independent articles; one dealing with psychology, the other with the history of natural science, but with a powerful common undercurrent concerning exactly the problem which we are examining here.

Both Jung and Pauli paid great attention to archetypal ideas. Pauli's subject was the appearance of archetypal ideas (archetypische Vorstellungen) in Kepler's thought.

The fact that Kepler wrote a lot about archetypes bears a relation to Neo-Platonism. According to Plato, ideas and the logical structure which joins them together are pictures of a reality which exists beyond the visible world. It is the world that really exists. We cannot grasp it with our senses,

but can only comprehend it with the help of our reason. Man's soul belongs to this eternal and unchangeable world of ideas and for that reason is immortal. It has the ability to see the structure of this real world just like a remembrance of a world from which it originated and to which it shall return again after death.

According to Kepler, archetypes are the soul's memories of the World of Ideas. They are thoughts of God which we can comprehend with the aid of our intuition and our intellect, as if awakening to a remembrance of the real world from which our soul originates. At birth it became tied to the material world and due to this we can get only a vague perception of the eternal structure of the real one.

On the basis of this we can understand why the microcosm reflects the structure of the macrocosm. Both of them reflect God's thoughts, upon which all existence is based.

And so it was that Kepler had an unshakeable confidence in the idea that natural phenomena could be governed by mathematics. Mathematics (geometry in particular) revealed the invariant, logical structure of reality in its purest form. He differed from Neo-Platonism in that he did not underestimate the senses, but rather, trusted completely that the changes of the phenomenal world – such as the planetary movements, for example – were governed by precise mathematical laws.

Kepler's research work was thus founded on the *faith* that archetypes dwelling in our souls are realized in the phenomena of the World of Perception. Kepler expressed this mystical fact which was the basis for empirical knowledge in the fourth chapter (book) of his main work, *Harmonices Mundi* (1691), in the following manner:

Commune enim habent harmoniae sensiles cum archetypalibus, quod terminos requirant eorumque comparisonem, ipsius animae energiam; in hac comparatione utrarumque essentia consistit.

viz. in English:

Thus, perceptible harmonies have in common with archetypal harmonies, that the concepts presuppose their mutual comparison, i.e., an activity of the spirit; this comparison is the essence of them both. (KVL)

Kepler was a mystic whose unshakeable faith in the "harmonies" of the world drove him ever deeper into the search for "archetypes". At the same time he was, nevertheless, a representative of empirical science, as the above-mentioned quotation illustrates: the essence of science is that archetypal ideas are found to correspond to "harmonies" in the phenomenal world.

The idea that this compatibility rests on the thought of God is a matter of faith. The mystery concerning the possibilities of empirical science is in any case connected with faith, and this is a factor that affects the strength and direction of our endeavours. From the point of view of the development of science, it is therefore not indifferent what kind of faith a researcher's work supports.

The Message of the Atoms

When penetrating into the foundations of quantum mechanics, many researchers have ended up with ideas which bear certain relations to the philosophy of the Middle Ages. The general reaction of the academic world toward such ideas has been that of absolute rejection. Nevertheless, it appears that the time begins to ripen for these new old ideas. Wolfgang Pauli has expressed this by saying that it is time to realize that "in certain respects they went too far in the 17th century". By this he meant that science began to develop according to a mechanistic world view and that this direction is now becoming one-sided and dangerous.

A factor which is worth emphasizing in this connection is the statistical nature of causality. Atomic research has shown that the laws of mathematics do not describe natural phenomena in just the manner as we had imagined. The laws only refer to statistical or average events, while individual events have their own freedom – an "indeterminism" – which can in no way be described and governed by rational laws.

Therefore there is reason to consider once again the idea that perhaps there is something behind the phenomena which medieval philosophers referred to as *anima mundi*. Perhaps there exists a spiritual element in reality which modern natural science has completely neglected.

It is interesting that these kinds of ideas arose in physics, where the materialistic world-view originated in the first place. A gap has appeared in the system of laws of nature of the so-called inanimate world, and this forces us to change the conception of reality which is the basis of our thinking. It also appears that arguments about God's effect on the events of the world are gaining scientific weight.

Complementarity

Not all who investigate the foundations of quantum mechanics actually approve of bringing spirituality into the scientific world-view. Not even Niels Bohr. *Henry J. Folse* has just published the work, "The Philosophy of Niels Bohr" (North-Holland, Amsterdam, 1985), which gives a very good picture of Bohr's philosophy, where complementarity is the central concept. The difference as compared to Pauli's philosophy is very clear. I have described this difference in a lecture which I gave on June 18, 1985, in Joensuu, Finland entitled, "Wolfgang Pauli and the Copenhagen Philosophy". Folse has pictured the difference in the same way, but the perspective is different as he looks at the matter from Bohr's point of view.

The starting points for Bohr's complementarity philosophy are first, a conception of reality characteristic of realism and second, the requirement that the objectivity of science be preserved regardless of problems concerning observations which one meets in atomic research. Positivism or instrumentalism was quite foreign to Bohr. He sought to understand *reality* and considered it to be clear that the atomic systems "really exist". In this sense,

all the important representatives of the Copenhagen school – Bohr, Heisenberg, and Pauli – were realists. There were, however, differences in their statements on the objectivity of knowledge as it regards atoms.

Through the years Bohr's thoughts, or at least his way of expressing himself, developed in a direction which Pauli did not accept. In emphasizing the objectivity of science Bohr eventually approved of the idea of a *detached observer*. This means that observations must be described objectively in such a way that it is not in any sense necessary to consider the effect of the observer's consciousness on the observation. Originally, Bohr emphasized that an observation presupposes an interaction between the observer and the object of observation. However, in later publications he always spoke about the interaction between *the instruments of observation* and the object. This is one of the changes in expression which aims at being able to "cut off" the observer's consciousness from the physical observation and from the description of phenomena.

Pauli consistently held onto an idea which Bohr has stated in the following manner: "We are not merely observers, but also actors, in the great drama of the world." Pauli entered a deeper level of critique in his analysis of the observation process than did Bohr. Pauli considered the instruments of observation as extensions of the observer's sense organs, *and to him the observation was always an interaction between the observer's consciousness and the object of observation*. So the observer is never "detached": by planning a particular method of observation and the manner of its interpretation he influences what he observes.

For Pauli, physics and psychology were two complementary sciences, between which there was no absolute border. Consciousness cannot be "cut off" from a physicist's conception of reality because one must keep in mind that the phenomenal world is always coloured by the properties of the human psyche (archetypes). For this reason the objectivity of science can only mean an *intersubjectivity*: an attempt to get different observers (each possessing a human psyche and sensory perceptions) to come to agreement to the greatest extent possible on circumstances concerning reality.

The Objectivity of Reality

The difference of opinion concerning the nature of observation are also reflected in Bohr's and Pauli's conceptions of reality. Actually, Bohr spoke very little of what we can objectively say about "particles" which are simultaneously "waves". Mere mathematical formalism was not enough for Bohr, however, and he tried to "understand" in an objective way what the atomic world was really like. He considered it impossible to form a perceptual image of it, but according to Bohr, complementarity supplied an objective description of the atomic world, in other words, it is possible to speak objectively about that "something" which in certain cases appears to our senses as a wave, and in others as a particle.

It is, nevertheless, difficult to understand what Bohr meant here by an objective description. Folse also states in his book that he must attempt to

describe something which Bohr did not state — but even his description remains rather meager.

Folse illustrates Bohr's thought with the help of an anecdote which Bohr himself used, though not quite in the same sense: A young man was urged to listen to a rabbi who was famous for his deep sermons. The young man listened to three sermons, after which he, greatly moved, described what he had heard, saying, "The first sermon was particularly clear. I understood every word. The second sermon was deeper. I did not really understand it, but the rabbi looked like he knew exactly what he was talking about. The third sermon was magnificent and deeply moving. I did not understand it at all and the rabbi looked like he did not really understand it either, but I had the feeling that it dealt with something truly supreme."

Folse applies this to Bohr in the following manner:

The first sermon regards the physical meaning and use of quantum mechanics. There is no problem here.

The second sermon deals with the general lesson which quantum mechanics gives about the nature of human knowledge. Bohr looks like he knows completely what he's talking about, but the matter is not so lucid to others.

The third sermon concerns the nature of reality in light of complementarity. It is quite clear that this question deals with something truly magnificent, but nobody seems to understand what Bohr is saying, not even Bohr himself.

It is very difficult to specify the concept of complementarity exactly. Nevertheless, it appears quite clear that the laws of nature can only be statistical in a "complementary reality". Bohr did not himself particularly highlight this but Pauli has emphasized it as being the most characteristic feature of the new conception of reality. From this Pauli is led into calling attention to the *irrationality* of reality: with the aid of reason we can govern natural phenomena only in a statistical sense, that is, in average terms; individual events always contain a freedom which cannot be described rationally.

This feature, on the other hand, is not at all in line with Bohr's view of an objective reality. He continually struggled against the idea that complementarity would open a door to mysticism "which is completely foreign to the nature of science". It was precisely in order to avoid this that he ended up emphasizing the principle of a "detached observer", which Pauli viewed as being in contradiction with the most essential message of quantum mechanics. As I see it, Pauli has here understood the situation more deeply than Bohr.

Veiled Reality

I would like to describe the effect of Bohr's complementarity philosophy on the conception of reality in the following manner:

1. In giving an account of observations we must use a language whose concepts directly relate to such subjects and their properties which are immediately perceptible to the human senses. Everyday language, then, can be completed in its descriptions of physical observations with the concepts and theories of classical physics because classical physics, too, is a result of a conception of reality in which directly observed objects and their observable properties are described. Our everyday language, completed in this way, can be referred to as a *macrophysical language*.

2. Any observation must be described *as a whole* by taking into account all instruments needed for the object's preparation and for the registering of the final results. The behaviour of the observational equipment can be described by using the macrophysical language. But a new language, which we can refer to as the *quantum mechanical language*, had to be developed for objects of the atomic world. The border between the observation equipment and the atomic object to be observed can perhaps be defined in various ways, but in each observation it must be clearly stated what the instrument consists of. All occurrences which are not caused by the (macrophysically described) behaviour of the measuring instrument must be viewed as being due to the object of observation and its interaction with the measuring instrument.

3. In regard to atomic observations one is forced to state that atomic systems (objects), which (on the basis of the preparation applied) must be considered as similar, behave in some measuring systems as "particles" and in others as "waves" – if the macroscopic language is used for their description.

4. It is precisely these kinds of experiences which have led to the development of a quantum mechanical language. Because the properties of waves and of particles are mutually contradictory, it is necessary to state that the macroscopic language is not sufficient for describing atomic systems. The starting point for the quantum mechanical language is the idea of *complementarity*: in different observations an atomic system can display mutually exclusive properties, as long as the observations are described in macrophysical language.

There is reason for distinguishing between an "object of observation" and real atomic system. An "object of observation" is an abstraction which we must use if the macrophysical language is used for the description of the object. We are forced to accept the fact that real atomic systems appear as objects of observation which have mutually contradictory properties. Quantum mechanical formalism has been developed for the description of these kinds of complementary systems.

5. If one is asked what the "real" atomic systems which appear as different objects of observation in different observations are like, there is no answer which could be given using the macroscopic language. With the aid of quantum mechanical formalism one can, however, state which type of objects of observation will appear if certain atomic systems are investigated under given conditions. The fact that mutually exclusive properties are ob-

served under different conditions was referred to by Bohr as the complementarity of the atomic systems, but he was unable to be more explicit in his description of "real" atomic systems.

Bohr himself claimed that the concept of complementarity created a possibility for describing the atomic systems objectively. Because he did not describe the nature of atomic reality more closely, he is considered to hold a positivist (instrumentalist) view of philosophy. If we are not satisfied with a purely mathematical description, we have no other alternative than either to be as taciturn as Bohr or to follow the trail staked out by Pauli: *to describe reality only symbolically*. Reality, from a human perspective, appears as if covered by a veil.

The expression "veiled reality" originates with *Bernard d'Espagnat*. He was evidently spurred on in the basic research of quantum mechanics by the fact that he considered the "orthodox" interpretation of quantum mechanics – i.e., the Copenhagen interpretation – to be unsatisfactory, but in the course of time he, too, has come to realize that human conceptions and mental images of the atomic world always fail to grasp it – it is behind a veil. This conception is very close to what Bohr said about the complementary nature of the atomic world without being able to describe it in more detail.

Pauli has described this situation more explicitly: in place of complementarity he emphasizes the statistical nature of laws. For this reason, a rational description can only apply to events on the average. It is possible to give a rational description of the atomic world, but only to a limited extent. The basic nature of reality is irrational, and this always becomes manifest when a rational theory is compared with reality with the aid of some observations. From individual events we see clearly that theories cannot grasp the whole of reality, and the lesson of atomic theory is that this is not due to a lack of knowledge, but rather, to the basic nature of reality.

This means that there is reason to discard Descartes' rationalistic philosophy, which has put its stamp on Western culture during the New Age. Science must confess that rational methods do not grasp the entire reality.

The Microcosm and the Macrocosm

While the researcher's interest was directed at the overall structure of the world – the macrocosm ("anima wandered into the heavenly realms") – during Renaissance, the point of burning interest for research during this century has moved to clarifying the micro-structure of the world. This holds true for both "animate" and "inanimate" subjects of research. Comparing the macrocosm to the microcosm is now important in a totally new sense. The macrocosm now means the world which has the same order of magnitude as man himself: the phenomena we can observe directly via our senses, without the aid of technical equipment. By the microcosm, then, we mean systems approximately of the order of magnitude of atoms and molecules, where different kinds of "magnifying" research instruments are absolutely necessary.

In atomic physics, microphysics is tied to macrophysics by Bohr's *correspondence* principle. It contains the requirement that microphysics be so structured as to contain macrophysics as a limiting case. This principle has been very useful in guiding the way for the development of quantum theory. In particular, it directed Heisenberg in a very essential way when he discovered the fundamental idea of quantum mechanics in 1925. The formalism of quantum mechanics has been so structured that it reduces to the equations of classical mechanics when quantum phenomena finally disappear.

Nowadays when philosophers are emphasizing the point that different languages should not be intermixed, many physicists have begun to consider the correspondence principle as something rather obscure, for it mixes together two worlds: the macrocosm, which is described by the macrophysical language, and the microcosm, which must be described by the quantum mechanical language. Here, as in many other places, the formal requirements of analytical philosophy have led to disproportionate emphases upon factors of secondary importance, so that the fundamental characteristics of physics have become obscured. It is also often said that the discussions of limiting cases, where Planck's constant h approaches zero, is meaningless, because h is a constant and quantum mechanics specifically assumes that this constant is not equal to zero.

The meaning of the correspondence principle is, however, quite clear in a physical sense. The limiting case, where h approaches zero, means those situations in which typical quantum phenomena become so small that they are no longer noticeable. If, for example, we examine the diffraction of radiation in a narrow slit then the limiting case is that where the width of the slit is very large compared to the wavelength of radiation. This is the limiting case where we can forget about the wave nature of the radiation and look at it as a shower of particles in which each particle travels along a straight path through the slit (and wave optics reduces to geometrical optics). Limiting cases where Planck's constant can be taken to be zero are of this kind.

It is true that the language of quantum mechanics is different from that of macroscopic physics. It is essential that one is forced to speak about "waves associated with particles" in quantum mechanics. There is, however, always the limiting case where it is not necessary. The quantum mechanical operators can be interpreted as being classical quantities in this case. If "both sides are divided by the wave function" in the quantum mechanical equations, all that remains are equations between the operators which in the limit mentioned above can be interpreted as equations containing classical quantities. Schrödinger's equation, in particular, reduces in the limiting case, when h approaches zero, to a fundamental equation of classical mechanics (the Hamilton-Jacobi equation). In this sense it is possible to say that classical mechanics can be derived from quantum mechanics by letting Planck's constant approach zero – but this kind of talk must be interpreted in the proper way physically.

From the point of view of the development of quantum theory, the correspondence principle has, in any case, been important. It may also be

that when relativistic quantum theory finds a more satisfactory form than at present, the correspondence principle will once again show its strength.

From a philosophical perspective, the meaning of the correspondence principle lies in the idea that quantum mechanics can in the sense described above be considered to be more general than classical mechanics. In this sense, classical mechanics is contained as a limiting case in quantum mechanics. This is in principle quite significant since the measuring apparatus is always composed of microphysical systems. It is therefore important that macro- and microphysical theories be mutually consistent. Macroscopic measuring devices can then, in principle, be used to control microphysical systems. But the fact that they are macroscopic means that quantum phenomena can be disregarded in the measuring apparatus and its behaviour can be described using the macrophysical language.

From the point of view of the unity of physics, the correspondence principle is very important, if not absolutely essential. One can say that quantum theory is applicable to both micro- and macroscopic physics as a new fundamental theory. But in the case of macrophysical bodies it can be replaced by the simpler macrophysical theory.

If someone asks, "Which world is the real one – the world which our senses detect or the world of atoms?", the physicist's response is: the atomic world is closer to reality. Even in atomic research we must start from observations related to the phenomena of the macroscopic world, but the aim of our research is to penetrate deeper into the basic structure of the world by using various measuring devices which "magnify" microscopic phenomena in various ways, i.e. increase the range of our senses. It is important that the theory of the micro-world is a generalization of the theory of the macro-world immediately perceivable by our senses: with its help one can govern phenomena of both the micro- and the macro-world, and therefore it gives a coherent picture of both levels of reality. The borders are simultaneously exhibited within which the theory of the macroworld can be applied.

In this connection, physicists have generalized the lesson they have learned from atomic physics to apply to empirical knowledge in general. The debates over the possibilities of attaining knowledge of reality, created by atomic research, concern the basis of empirical knowledge in general. One always runs up against similar fundamental problems in observations, as those encountered in atomic physics. In atomic physics, a critical researcher cannot just disregard these questions. Nature itself reminds the researcher of certain fundamental limitations always associated with empirical knowledge.

The Message of the Archetypes

There is reason to return once again to the concept of archetypes. It is worth emphasizing that archetypes also appear in the structure of the phenomenal world, not only in our internal world and in the operation of our psyche. We instinctively arrange the stimuli which arrive from the external world to our senses, according to the archetypes of our unconscious psyche. Observations

themselves never grasp reality itself – as the strict empiricist assumes – but rather, the archetypes combine these sensory stimuli, forming certain “outlines” (Gestalt) and in this way a picture of the phenomenal world is formed, corresponding to the properties of the human psyche. The phenomenal world would certainly appear different to a being with different senses and spiritual faculties.

One can say that *it is the archetypes which form the bridge between our theoretical concepts and the regularities of the phenomenal world.* That bridge, however, lies hidden in our unconscious. Only in special circumstances can we obtain from our unconscious an outline of an archetypical image, which in that case strongly influences the context of our consciousness.

One archetype which Pauli and Jung have paid special attention to is the archetype of the conjunction of opposites. The “collective unconscious” of our time seems to be strongly influenced by it. In physics it manifests itself in the form of complementarity. Due to this, problems concerning the encounter of faith and knowledge are now demanding clarification – even within the framework of our Lutheran Church in Finland.

The fact that human knowledge is possible, nevertheless remains a mystery. Archetypes do, however, shed some light on this problem. They associate the “outlines” (Gestalt) and the regularities of the phenomenal world with the operation of the human psyche and give some kind of “explanation” for the fact that the constructs of the intellect reflect the structure of the phenomenal world in a miraculous fashion. It nevertheless remains a mystery, i.e., that the sensory stimuli which come from the external world, can be organized at all according to the outlines of the archetypes.

This brings up the question of the *origin of archetypes*. Kepler believed that these were thoughts of God, which the soul of man grasps through contemplation because man is an image of God. A materialist points out that the evolution which has taken place in nature over millions of years has stored up in man’s DNA molecules certain operational instructions and thus a picture of the nature of reality. According to the biological concept of a human being, man’s behaviour is, indeed, based on the information deposits in these DNA molecules – information even for spiritual behaviour.

From the point of view of natural science, this is a noteworthy perspective. Archetypes reflect the fundamental characteristics of man’s instinctive behaviour and it is precisely this information contained in the DNA that directs the functioning of his organs – as well as the operation of his nerves and brains.

Another point is that the materialist’s view concerning the birth of such information contains a decision of faith which can be termed the “religion of chance”. It is no more scientific than any other religion. Actually, scientific criticism may lead a researcher to question how such a huge amount of information as is contained in a man’s DNA could originate from “pure chance”.

The way a materialist has of using the concept of “chance” is completely unscientific, nor is there any difference between it and what is meant by a

“miracle”: it is something which has no scientific explanation. I personally feel that “miracle” is a better word for describing what is necessary in mutations in order that the manifest purposefulness of evolution would be comprehensible: it is precisely a *miraculous* thing, it cannot have been created by “pure chance”.

An important aspect appears in such debates: the philosophy of science cannot be strictly separated from the philosophy of religion. Of course the researcher of the philosophy of science can – for the sake of materialistic faith, for example – forbid discussion on matters which lead into the area of faith. It is necessary to stress the fact that scientific criticism does not demand this, on the contrary, it presupposes open discussion of any mystery into which the critical examination of the possibilities of empirical knowledge leads.

In the light of atomic theory, the limits of man’s knowledge and the mystery contained in its possibility become particularly apparent. Human knowledge will never be able to grasp reality itself. It will forever be concealed from us behind a veil. It is, fundamentally, irrational and man can picture reality only through metaphors and symbols. It is a miraculous fact that this description succeeds to the extent which the development of natural science in the modern age has demonstrated.

Translations of the German Quotations into English*

Translated by *Eugene Holman*

16 The relativistic doublet formula now undoubtedly appears to indicate to me that not only the dynamic concept of force but also the kinematic concept of movement in the classical theory will have to undergo profound changes.¹ (For this reason I have, without exception, avoided using the label "orbit" in my work.) Since this conception of motion also underlies the principle of correspondence, its clarification must, most importantly, be valid for the efforts of the theoreticians. I believe that the values of energy and momentum of stationary states are something which is much more real than the "orbits".

The (still unattained) goal must be to deduce these and all other physically real, observable properties of stationary states from (integer) quantum numbers and quantum theoretical laws. We are not, however, permitted to want to beat the atoms into the fetters of our prejudices (one of which, in my opinion, is also the assumption of the existence of electron orbits in the sense of traditional kinematics), we must, rather, do the converse and adapt our concepts to experience.

¹I consider this to be certain - despite our good friend Kramers and his colorful picture books - "And the children - they enjoy hearing it." Even if the demand posed by these children for illustrative presentation is a justified and healthy one, it should still never be allowed to serve in physics as an argument for the retention of specific conceptual systems. Once the conceptual systems have been clarified the new ones will also be illustrative.

18 I'm more and more expecting a further revolutionizing of the basic concepts in physics. In connection with this particularly the manner in

The numbers in the margin refer to the pages of the maintext in this book

which the space-time continuum is currently introduced into it appears to me to be increasingly unsatisfactory. (Naturally it is brilliant not to use time any more for sequencing causal series - as once in May - but rather as a playground of probabilities. If, however, instead of "brilliant" we say "foolhardy" it would be at least as true. Something only really *happens* when an *observation* is being made, and in conjunction with which, as Bohr and Stern have finally convinced me, entropy necessarily increases. *Between* the observations nothing at all happens, *only time* has, "in the interval", irreversibly progressed on the mathematical papers.)

In the interim I have continued my excursion into the 17th century. The fact that Newton virtually put space and time at the right hand of God, and, indeed, at the place of the Son of God which became vacant after having been chased away by Newton, is an especially cutting episode of intellectual history which first became known to me after I had read your lecture on Newton. As is well known, going and fetching space and time from this Olympian height required a quite extraordinary intellectual effort. The work was even artificially made more difficult by Kant's philosophical attempt to deny human reason access to this Olympian height.

For this reason the time when space and time were *not yet* up there and, indeed, the moment just before this fateful operation, is particularly interesting for me. This is the reason for my study of Kepler.

This problem is very closely connected with the other problem of *the idea of reality*. When the layman says "reality" he usually thinks that he is speaking about something which is a self-evident known; while for me working on the elaboration of a new idea of reality seems to be precisely the most important and extremely difficult task of our time. It is this, too, which is what I mean when I emphasize that science and religion *must* have something to do with each other. (I do *not* mean "religion within physics", nor do I mean "physics inside of religion", since either one would certainly be "one-sided", but rather I mean the placing of both of them within a whole.) I would like to make an attempt to give a name to that which the new idea of reality brings to my mind: the idea of the reality of the symbol. On the one hand a symbol is a product of human effort, on the other hand it is a sign for an objective order in the cosmos of which man is only a part. It contains something of the old concept of God as well as something of the old concept of matter. (An example from physics: 'the atom'. The primary qualities of filling space have been lost. If it were not a symbol how could it be "both wave and particle"?) The symbol is

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symmetrical with respect to 'this side' and the 'beyond', that is to say, dual in the sense of your suggested view of the process of perception; it has a relationship to 'observing' and to 'comprehending', it can be mathematical or also even more primitively picture-like. The symbol is like a god which exerts an influence on man but which also demands from man that he have a back effect on him (the God symbol). It seems to me that only in this manner does the this side obtain any sense and it is just that which to me seems to be lacking in Schopenhauer. (For him: "Pessimism" as opposite position to the "positive superlatives").

29 We English physicists would be frightfully happy if in the future the views represented in the following article would demonstrate themselves to be incorrect. However, since Mr. Bohr is a nice person a joy of this type would not be very kind, and since he is a famous physicist and is more often right than wrong, we have only a slight chance for the fulfillment of our hopes.

30 Dear Mr. Fierz,

Thank you very much for your letter. - If we go over to the present: Mr. Destouches also visited me (on January 3) and what he told me was similar to what he told you. The fact that Catholics and Communists in France have united against complementarity (which includes "indeterminism") does not surprise me. Both are, you see, psychologically bound to an *eschatological expectation*; whether this is to be found in this life or the hereafter is relatively unimportant. The "iron compulsion" of history - whether it terminates with the triumph of the "good" on the Day of Judgement or with the final establishment of world communism - is, of course, not allowed to be subjected to question. "Where would we wind up if we were to subject the "breakdown", that is to say, the end of the world (= the end of capitalism) to a purely probabilistic scrutiny?" I am sure that that is the psychology. (I was long ago struck by the fact that the newspapers - particularly the Anglo-American ones as well - report completely erroneously about the relationship between Christianity and Communism, since they emphasize the difference rather than the analogies. There we should certainly also make reference to the analogy between the former treatment by the church of adherents of the doctrine of heliocentrism with that of genetics based on Mendel's laws and its representatives in contemporary Russia. It should, however, also be pointed out that B. Russel in his history of philosophy and elsewhere emphasizes the analogy between Christianity and Communism in just that same manner as I have here. May God preserve the obstinate people.)

I can only complete Destouches' report with a story about Mr.D.Bohm (presently in Sao Paolo, Brazil). /There follow some sarcastic remarks./

What Mr. Bohm found particularly teasing and irritating in me is the circumstance that I declare myself not to be a positivist. While he believes, indeed, to have "demonstrated" that only "the positivistic prejudice" stands as an obstacle to the acceptance of his causal doctrine of hidden parameters.

*Because -- he concludes sharp as a knife --
nothing can be which is not allowed to be!*

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Bohr's expression "correspondence" served as an aid to me when, then, I was trying to give a name to the *positive* principle which lies at the basis of quantum mechanics. (*After* putting forward wave mechanics he continues to speak of a "correspondence argument" - see Naturw. 21, 245-250, 1933, particularly the passage on page 246, top of the second column). That statistical behavior of many similar individual systems which have no contact whatsoever with one another ("windowless monads"), without, on the other hand, being causally determined, has, of course, in quantum mechanics been interpreted as the *last* law-governed fact which cannot be further reduced (approximately as was the case for Galileo with respect to uniformly accelerated falling bodies). In my lecture on complementarity, originally published in the journal "Experientia" and now available as an offprint, I thus tried to use the expression "correspondence" in a more general sense than Bohr had, in a way which would specifically characterize the positive side of a quantum mechanical description of nature. It is certainly this *statistical correspondence* which mediates between continuum (wave image) and discontinuum (particle image). (This in a somewhat more general way than the mediation between 'quantum theory' and 'classical theory' in Bohr's writings). There I did *not* explicitly state that for me the intellectual derivative of the 'correspondentia' of the Middle Ages ('correlations') clearly seems to glimmer through in the term "correspondence". In both cases, however, we are concerned with a form of describing nature in terms of laws which transcends normal causality and which is based on some kind of analogy. (This is also the case with Leibniz's prestabilized harmony).

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The single systems of quantum mechanics are "windowless monads" and, nevertheless, the correct fraction can always be found which reacts as calculated (apart, naturally, from the expected statistical fluctuations).

The tertium comparationis of the quantum mechanical case with that of the synchronistic phenomenon is the *mutually tuned behavior of different events* (not bound in a deterministic-causal sense). (It is on this, of course, that the concept of 'physical situation' in quantum mechanics rests, *not* on a direct mutual influence of the objects in question.)

The quantum mechanical situation is naturally not only a degeneration of the more general "synchronicity" (this to be understood as a working hypothesis suggested here), but *also* a "rational generalization" of normal deterministic causality (Bohr). When the fraction is one (instead of between zero and one), that is, of course, a special borderline case, as, indeed, the old deterministic causality seems when observed from the standpoint of quantum mechanics. I have no doubts that the quantum mechanical "statistical correspondence" lies much closer on the side of old determinism than on the side of the synchronicity phenomenon. Observed from the standpoint of this phenomenon quantum mechanics must appear to be a *very weak* generalization of the old causality. And, nevertheless, quantum mechanics seems to me also to have that road sign towards the other direction, towards the one where it is no longer possible to speak of arbitrary reproducibility at all. To me quantum mechanics seems to occupy a kind of intermediate place.

This is my momentary view and the thoughts in your letter do not seem to fit it badly at all. The *success* of the 'reasonable belief' - and with it also the possibility of laws of nature - appears to me *always* to rest on an archetypically conditioned coincidence of our expectation (psychologically) with an external natural occurrence (physically). For the abstract arranger there is just *not* any actual difference between 'physical - psychological'. However, for me it appears increasingly strongly to be the case that "natural-scientific thinking" in this respect is only a special case of more general possibilities. Perhaps we will return to this once again. (It has to do with the 'preparation treatment')

35 Now there comes the major crisis of the quantum of action: one has to sacrifice the unique individual and the "sense" of it in order to save an objective and rational description of the phenomena. If two observers do the same thing even physically it is, indeed, really no longer the same: only the *statistical averages* remain, in general, the same. *The physically unique individual is no longer separable from the observer* - and for this reason it goes through the meshes of the net of physics. The individual case is *occasio* and not *causa*. I am inclined to see in this *occasio* which includes within itself the observer and the selection of the experimental procedure which he has hit upon - a revenue of the *anima mundi* which

was pushed aside in the seventeenth century (naturally "in an altered form"). *La donna è mobile* - so are the *anima mundi* and the *occasio*.

Here something has remained open which previously appeared to be closed, and it is my hope that *new concepts*, which are uniformly *simultaneously* physical and psychological, can force themselves through this gap in place of "parallelism". May "more successful offspring" attain this.

Now I come from the physics of the 20th century immediately back to Newton and even somewhat further back: to the natural philosophy of the Italian renaissance. That has very much to do with the end of your letter which deals with Newton; it is quite proper because the end contains the beginning latently, and that which is still older is always the new (this is the wording with which I always enjoy refuting the conservatives and the revolutionaries at the same time). The function of the English Neoplatonists on Newton was evidently to produce the connection with the natural philosophy of the Renaissance, since at that time the general mode of thinking was very Neoplatonic (since Ficino or probably for an even longer time) and *at that time space completed itself (= materialized) with respect to matter!* In my opinion this is a matter of the anticipation by philosophy of a turn in natural science: It was necessary to get away from the peripatetic tradition according to which things "seek a place", this tradition having been justified with the idea *that places in space have such physical qualities*. This thesis had become controversial during the Renaissance, was retained by many (including even the Neoplatonist Giordano Bruno - for him the *infiniteness* of space makes pantheism possible), but it was rejected by many. Of these many I would like here, on the basis of my extremely fragmentary historical knowledge (may it be brought up to standard from Basel - blessed be this humanistic polis!) *Bernardino Telesio* (1508- 1588) and *Francesco Patrizzi* (1529-1597). Telesio denied the physical qualities of points in space (if I am not mistaken, he also emphasized their complete equivalence, that is to say - expressed in more modern fashion - he stressed the homogeneity of space); Patrizzi, in turn, defended the "absolute" existence of space beyond matter. (Campanella is also worth looking into!) - The degree to which the problems of Leibniz, Spinoza, and Newton were rolled up during the Italian Renaissance cannot be emphasized too much!

But yet another essential element of the Neoplatonism of the Renaissance (see Ficino) is the *anima mundi*, which was also an *anima movens*. Each planet had an individual soul, but how did these come into contact with one another: also still spiritually through the *anima mundi* in which the single

souls take part. (NB I see Mr.Fludd before me; how he immediately rumples his forehead whenever he hears the word "*part*" - thus, for his sake we shall say: "with which the single souls, insofar as they belong to the light principle, are identical").

In the 17th century, however, the *anima mundi* went out of fashion, this idea faded away (I would very much like to know how your epigon, H.More and his circle, regarded that - what kind of a Neoplatonism is it, after all, which *lacks* the *anima mundi*?) And it was just through the resulting gap that proportion, geometry, and mathematics forced themselves into the ideas concerning motion and forced (those interested) to use empiricism and measurement. This process can be seen distinctly not only in Kepler but also in Galileo. He *rejected* not only the Aristotelian-peripatetic tradition but also Neoplatonism, including the *anima mundi*, and went back to the Pythagoreans *and to Plato himself* ("that which is still older is always the new"!)

However, along with this progress (analytical geometry - Newtonian mechanics) space made its way into the Olympian heights of the absolute and the relationship between soul and matter became a special problem which disappeared in the twilight of "parallelism", just as Venus disappears in the light of dawn.

But now we appear to be beginning, to suffer as a consequence of their having gone too far in the 17th century (cf. my work on Kepler), and from that time there come "revenues"¹ which pursue me at night and sometimes during the day as well - just as Venus returns as the evening star². When something becomes invisible, it still remains effective, and the general theory of relativity has, with its "time-space" "crumpled" by matter, already restored for us the idea taken over from the peripatetics of the physical quality of points in space ("places"), having re-introduced it in the changed form of the g_{ik} field (even if it was not simultaneously able to restore the entire *horror vacui*!).

¹ Scandinavian: "Gengangere" (at the same time the title of Ibsen's well-known play. The syllable *gen* is the same root as that found in English "again". That is, of course, to say that the English word is derived from the older Danish (*igen*).

² I believe that *every* increase in consciousness takes place in such a manner that it is also accompanied by a disappearance of something in the unconscious which was previously known and which always returns much later. I want to express that with the image of Venus and also with the saying "that which is still older is always the new."

48 We see here that Newton did not want to ascribe any compelling force to natural laws. They have been discovered empirically and they reflect that

which normally takes place. Neither do they have any eternal validity, just as God does not want to make the structure of the world something eternal. With this, the attempt is made to see the world as something which is constantly becoming and developing in the flow of time. In this way, time becomes the order of creation, as it is, of course, also the attribute of the eternal duration of God, the Creator.

1) *Sought*: an "intermediate realm" (between matter and spirit. 56
Mental or respectively "neutral")

It is 100% *accurate* that "the deification of space irritates me, that is to say, it moves me emotionally. Thus, the "anima" stands behind the matter."

The "anima" serves as the intermediary between matter and spirit, between the internal and the external. Through it I know that the "supercelestial place" of the ideas and the *chthonic depth* of man can only be reached simultaneously. (It is quite possible that already Plato was no longer aware of that. Heraclitus was certainly aware of it.)

For this reason it is important for me to distinguish whether the *anima* wanders into space, as in the writings of *Patrizzi* and *Bruno*, or go *completely* down into matter, as was believed by the alchemists. The first claim specifically violates the symmetry (or identity) of inside vs. outside to which the alchemists were closer with their psycho-physical uniform language.

But this wholeness is also in *matter*; and, indeed, it seems to me that for us the *psycho-physical problem* plays a role similar to that played by chemical processes for the alchemists and by cosmic space for the astronomers and physicists of the 17th century. Since the "anima" only enjoys staying in the unknown.

The concept of complementarity does not in any way mean that we abandon our position as detached observers, it should, on the contrary, be regarded as the logical expression of our situation with respect to objective description in this realm of experience. The realization that the interaction between the measuring instruments and the physical systems being investigated constitutes an integrating component of quantum phenomena not only revealed an unexpected limitation of the mechanical conception of nature which ascribed certain properties to physical objects, but it forced us

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to devote special attention to the problem of observation when arranging experience.

In comparison with the extension of the mechanistic mode of description which required the presentation of the features of wholeness in the atomic phenomena, the integrity of the organism and the unity of the personality confront us with a much further-reaching generalization of the framework for the consistent utilization of our means of communication. It should be emphasized in this context that the distinction between subject and object which is essential for unambiguous description is retained by the fact that we, so to speak, introduce a new subject which does not appear as a part in the content of the communication in conjunction with any communication which makes reference to us ourselves. It hardly requires any special emphasis to note that it is just this freedom in the choice of a separation between subject and object which creates leeway for both the diversity of the phenomena of consciousness and the rich opportunities of human life.

72 But I would like to return once again to the relation of the viewpoint represented in my article ("Background physics") to the article by Bohr in the Planck issue of *Die Naturwissenschaften* (Nr. III in "Atomtheorie und Naturbeschreibung"). The question of this relation was, indeed, brought up by you. In the interim I have once again thoroughly discussed with C. A. Meier the passages in this publication by Bohr dealing with the parallels between physics and psychology which are quoted in my last letter. The most important thing is that *Bohr's expositions are written completely from the standpoint of pure psychology of consciousness*. For this reason Bohr also understands "unity of personality" and "unity of consciousness" to mean something quite different than we do. Thus, it seems to me that Bohr's analogies, insofar as they pertain to *something psychological* (have a look at the scheme corresponding to these analogies in my last letter) are an arbitrary construction without any deeper significance. Bohr *never* uses the concept of the unconscious; this concept is so distant from him that he has never understood its meaning. I also remember conversations we had on this topic. He admitted with no hesitation that dreams could be used as sources of information - he said that all of the ancient peoples had already done that - but he insisted that dreams also have a conscious content. (On this point his position was similar to that which I have found to be typical of the Chinese.) Summarizing, I thus regard the standpoint of my essay to be a significant modification and completion of Bohr's analogies concerning physics and psychology, as it turns out through *acceptance of*

the concept of the "unconscious", as used by modern psychologists of the Jungian and other schools.

Most importantly, though, this area, as has already been touched on, is marked by relations of reciprocity which are connected with the uniform character of consciousness and demonstrate a striking similarity with the physical consequences of the quantum of action. Here it is a question of universally known peculiarities of human feeling and desire which totally elude representation by graphic images. In particular, the apparent opposition between the continuous progress of associative thinking and the preservation of the unity of the personality finds an expressive analogy in the relationship of the wave description of the behavior of material particles governed by the superposition principle to their indestructible individuality. The unavoidable influence of atomic phenomena by their being observed corresponds here to the well-known change of the coloring of the psychic happenings which accompany every direction of attention to its different elements.

Here it may also be permissible to make reference to the relationship between the regularities in the area of *psychology* and the problem of the causality of physical phenomena. Considering the contrast between the feel of free will which dominates spiritual life, and the evidently uninterrupted interconnection of causes of the accompanying physiological processes the thinkers have, of course, not failed to notice that we can here be concerned with a relationship of complementarity which cannot be depicted graphically. Thus, the view has often been represented that pursuing the brain processes down to the most minute detail, something which can certainly not be done but which can be imagined, would reveal a chain of causes which would offer an explicit diagram of those psychological events in which feeling has a decided emphasis. Such a mental experiment does, however, come into a new light when, after our discovery of the quantum of action, we have learned that a pursuit of atomic processes down to the most minute detail is not possible, and that every attempt to acquire knowledge of such processes will be accompanied by an intervention into the course of its unfolding. According to the viewpoint here mentioned about the relationship of brain processes and psychological events we must thus be prepared for the fact that an attempt to observe the first of them will bring with it a significant change in the accompanying feeling of desire. Although we are here so far dealing only with more or less appropriate analogies, one can scarcely release oneself from the conviction that the facts which are revealed by the quantum theory but are inaccessible to normal imagination provide a means to shed light on the general problems concerning human thinking.

For this reason I find the time particularly interesting, when space and time were *not yet* up there and, indeed, the moment precisely *before* this fateful operation. This is the reason for my study of Kepler. I have promised C. A. Meier to deliver a lecture at the Psychological Club on "The influence of archetypal ideas on the construction of scientific theories of Kepler". Kepler uses the words "archetypes" and "archetypal" in a way which is sufficiently similar to the use which Jung makes of these concepts for it to be unnecessary to emphasize any special difference. (They probably both use the same classical sources). Thus I believe that I can prove a not uninteresting connection from Kepler's writings between his spherical symbol of the trinity, which pulls its way through almost all of his writings, and his passionate heliocentric belief (in this respect Kepler's expositions in "Paralimpomena ad Vitellionem", his book on optics, are particularly instructive).

- 77 Every partial recognition of this order in nature leads to the formulation of statements that, on the one hand, concern the world of phenomena and, on the other, transcend it by employing, "idealizingly", general logical concepts. The process of understanding nature as well as the happiness that man feels in understanding, that is, in the conscious realization of new knowledge, seems thus to be based on a correspondence, a "matching" of inner images pre-existent in the human psyche with external objects and their behaviour. This interpretation of scientific knowledge, of course, goes back to Plato and is, as we shall see, very clearly advocated by Kepler. He speaks in fact of ideas that are pre-existent in the mind of God and were implanted in the soul, the image of God, at the time of creation. These primary images which the soul can perceive with the aid of an innate "instinct" are called by Kepler archetypal ("archetypalis"). Their agreement with the "primordial images" or archetypes introduced into modern psychology by C.G.Jung and functioning as "instincts of imagination" is very extensive. When modern psychology brings proof to show that all understanding is a long-drawn-out process initiated by processes in the unconscious long before the content of consciousness can be rationally formulated, it has directed attention again to the preconscious, archaic level of cognition. On this level the place of clear concepts is taken by images with strong emotional content, not thought out but beheld, as it were, while being painted. Inasmuch as these images are an "expression of a dimly suspected but still unknown state of affairs" they can also be termed symbolical, in accordance with the definition of the symbol proposed by C.G.Jung. As ordering operators and image-formers in this world of symbolical images, the archetypes thus function as the sought-for bridge

between the sense perceptions and the ideas and are, accordingly, a necessary presupposition even for evolving a scientific theory of nature. However, one must guard against transferring this a priori of knowledge into the conscious mind and relating it to definite ideas capable of rational formulation.

But it can be seen clearly that the anima mundi is no more than a kind of relic in Kepler's mind and plays a subordinate role compared to the individual souls of the various heavenly bodies. Although Kepler's ideas reveal quite unmistakably the influence of Paracelsus and his pupils, the contrast between his scientific method of approach and the magical-symbolical attitude of alchemy was nevertheless so strong that Fludd, in his day a famous alchemist and Rosicrucian, composed a violent polemic against Kepler's chief work, *Harmonices mundi*. In Section 6 we shall revert to this polemic, in which two opposing intellectual worlds collided.

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The second subject of your letter, specifically Jung's views on "synchronicity" etc., is more difficult. When I visited him at the end of July (since then I have neither seen him nor written to him), he emphasized as a particularly important point that he wanted to restrict "causality" to "concrete" or "measurable" causes which are located in space and time (in order to *avoid* including anything like "magical" or "symbolic" causes outside of space and time in the concept of causality). That is naturally a very decisive point, since only in this sense are Schopenhauer's "crossed connections" of similar events "acausal".

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For me, when dealing with so-called "synchronistic" phenomena it seems even more essential that with them factors are involved (in a very provisory manner called "state of consciousness" and "archetypical effects"), that elude control to such a degree that a deliberate reproducibility of these phenomena is not available (this is also the reason for their connection with fate, *heimarmene* /all compelling fate/, χρόνος /time/, and *tyche* /unrecognized coincidental reason/).

Schopenhauer speaks metaphysically about "will" which penetrates space and time, the "principium individuationis", as he calls them, and contrasts the "nexus metaphysicus" with the "nexus physicus". Jung uses a terminology which is psychological-scientific instead of philosophical-metaphysical. He tries to generalize the parallel connections onto such relatively rare "borderline phenomena"¹, speaking in this case of a

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"connection (nexus) through similarity or 'sense'". Following his psychological intuition he establishes a link with the concept of time by introducing the term "synchronicity". Here we are dealing with a first attempt to advance into a very new area: the idea of Jung has, up until now, only rarely been confronted in detail with empirical results of ESP.

*

Summarizing, I would like to point out that it is precisely the correspondence of the *sense*, the meaningful coincidence, of ideas which have appeared at approximately the same time in different branches of science from which I have allowed myself to be led, in this article, outside of my narrow area of specialization: "correspondence", "complementary pairs of opposites", and "wholeness" appear independently both in physics and in the ideas of the unconscious. The "unknown" itself has a certain analogy to "field" in physics, and both are essentially moved into the abstract and the paradoxical by a problem of observation. In physics, however, we are not concerned with "archetypes" which reproduce themselves, but rather with "statistical laws of nature with primary probabilities", but both formulations meet in the tendency to broaden the old, narrower idea of "causality (determinism)" to a more general form of "connections" in nature to which, indeed, the psychophysical problem also refers. Examining the circumstances in this way permits me to expect that the ideas of the unconscious will not develop further within the narrow framework of their therapeutic use, but rather that their connection to the general stream of the science of life phenomena is decisive.

¹Here I would like to raise the question of whether the most primitive "psychic" components which have been assumed by Rensch and by him also attributed to the anorganic do not express themselves specifically just in such borderline phenomena.

- 84 On the question "where does life begin" I reflected in the connection with a book on evolution written by the German zoologist *Rensch* (I quoted it in the *Dialectica* essay commemorating Jung's 80th birthday). This work is faithfully written according to the neo-Darwinist line; nevertheless, the author has some special views concerning the relationship of the physical to the psychical which I found stimulating. (Incidentally, these were influenced by the German psychiatrist *Ziehen*). In particular, Rensch mentions that the "psychological parallel components" could not possibly have "suddenly sprung up" in the otherwise continuous ontogenesis. Thus, he would claim, the so-called inanimate (non-organic) matter already must show "weak psychological parallel components". This conclusion seemed

reasonable to me, nevertheless, the author did not indicate the phenomena in which these weak components might express themselves.

For "domestic use" I have constructed the idea that these [components] (and consequently life) express themselves *principally* in *non-reproducible* phenomena, from which no immediate inductive conclusions can be drawn.

This is probably the same thing which C.G.Jung names "inconstant connection through contingency" as well as the "synchronicity phenomenon". Let us be brief and call them the " Σ phenomena". They may give reason for consequences with "significances" (in the sense of the statisticians), which are neither random series (since no probability exists), nor regularities (since a regularity is not reproducible). From the standpoint of a statistics which is based on the calculation of probabilities (or rather of its representatives) these "spurious significances" mean "nothing at all". That is to say, as concerns the traditional scientist they go "through the mesh of his net".

That is how I imagine the "beginning of life", at which time the Σ phenomena could express themselves microscopically as "chemical patterns".

I have the impression that the ESP people (Rhine, Soul, etc.) observe something similar.

Now I should like to present the question to you of the *relationship* of these ideas to those in your letter.

To me they seem to be definitely present! *Gödel's formulation* reminds me considerably of these Σ phenomena, with respect to which the concept of probability no longer applies. Could it be so that it cannot be determined whether these phenomena *contradict* the laws of the "anorganic" or not?

Your other *motif*, the *Moebius strip*, could have something to do with the overall course of the process of life. Specifically, I always imagine the Σ phenomena to be nothing more than a *transitional phase*, as something temporary. Then, somewhere, a *causal fixation* enters the picture, makes it quasi superfluous, and determines its further course. The way I imagine this fixation is that from the standpoint of the normal physical-chemical laws it must indeed always be "possible" although, nevertheless, it would be more or less improbable from the standpoint of these laws.

Then come occasionally Σ phenomena of a different type, etc. Seen from the standpoint of the whole the Σ phenomena and the causal phenomena could thus be regarded as the two sides of a Moebius strip and just, as a unity, make up life.

How do you react to this "interpretation" of your letter? Does it appeal to you? Does anything additional come to your mind?

89 What could I say more distinctly about that which is included in my essay on Kepler? Yes, is it then really only implied there? I have already known something for a long time:

1.) Fludd supports the position which is counter to the natural sciences.

2.) I myself am not only Kepler, but also Fludd. But - as Mr. Panofsky has so classically expressed: I cannot exactly "empty out Kepler with the fluctibus" (NB. neither with Fludd /a pun based on homonymity of the name *Fludd* with the word *Flut* 'flood', in addition to which Fludd's Latin name was *fluctibus*/ nor with the River Ganges).

3.) The opposition Kepler - Fludd is reflected on the level of the subject in the oppositions:

Protestantism - Catholicism

physics - psychology

natural scientific thinking + perception - intuitive feeling

People such as *Zimmer*, *A. Huxley*, or *Wicheler* portray for me *only* the right side of this listing, without the left side. Consequently they are instructive for me, but unsatisfactory for the *conjunctio*. The same holds true for India, Lao Tsu, etc.

All of this has also played a role in my dreams for a long time. [There it is occasionally reproduced geographically by the opposition Italy - Holland, with Zurich in the middle.]

Sought is a process of conjunction (unification of opposites), but I have only partially succeeded in this. Nevertheless, an exotic woman (Chinese, with slanted eyes) appeared first, later also a dark foreign man with a relatively fair complexion, as a figure in my dream who seemed to know something about the unification of opposites which I sought.

The dreams emphasize the *objective* significance of the contrary position to the natural sciences in the form of a "calling" to be a "professor" at a university, this often being a *new* university, but often also our Zurich Polytechnic, to which I have just received a first "calling" which I, characteristically have not yet accepted - or the foreign man seeks to be admitted to study at the Polytechnic, but encounters resistance (i.e. from the side of conventional contemporary science)¹.

I am convinced that these dream motifs which have reoccured over a stretch of many years have something to do not only with my personal stagnation, but also, on a more objective level, with the more profound reasons for the stagnation of physics. Unfortunately, I am *also* convinced that the task of understanding and interpreting such dreams far exceeds the capabilities of all the psychologists of our time. Neither do I consider it of primary importance to discuss *dreams*; on the contrary, I consider it important to discuss directly itself the problem of the *objectivity of the counterposition to the natural sciences*.

And it is *this* problem which is behind my essay on Kepler. Often I think that I can only come to the *Conjunctio* I long after if I could say or formulate something which would shock the representatives of both conventional religions and of conventional sciences. But I do not precisely know what it really is.

¹ Dreams also occurred in which I am supposed to deliver a lecture in an auditorium to people I do not know.

Recently the word "wholeness" is used by Bohr more regularly and more frequently, always in conjunction with "complementarity", among other things also *within physics*. This happens when he speaks of the wholeness and indivisibility of an experimental procedure used in quantum mechanics. He wants, indeed to include this wholeness and indivisibility in the definition of the "phenomenon", since the observation interrupts the connection of phenomena in an "irrational" way. It is this irrationality of observation which prevents the Ψ -function from remaining "Platonic" - that is to say, from remaining in a "metaphysical space". Because of it the "reality" of the Ψ -function becomes "symbolic", which is something completely different from "crystal clear", very much to the distress of the Spinozists (Einstein), the Cartesians (de Broglie) and the intellectual estheticians (Schrödinger).

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Bohr is typically antiplatonic (cf. to this his complementarity of "clarity" and "truth") and he now would like to see in "complementarity", as it was manifested in physics, *a general model for the resolution of conflicts, for unifying pairs of opposites* - I myself like to say *conjunctio*. For example, he attempted to apply this to ethics (good - evil, justice - love), but he was particularly interested in applying it to the opposition *physis* - *psyche* (the psycho-physical problem). For him the central point here is always *observation*.

Why does Bohr have a so extraordinarily strong aversion to the concept of the "unconscious"? Seen completely apart from the personal views he continuously points out that the utilization of this concept in the psychology of the unconscious has resulted in too little attention being paid to the role of observation. He says that in this psychology it should also be emphasized that after each observation a *new* phenomenon comes into being. He senses here at once a certain danger that the concept of the "unconscious" has the tendency to withdraw Platonically into a "metaphysical space". The symbol which expresses reality validly and adequately must, rather, differently from what is the case in classical

physics and in such things as its field concept, also give expression to the irrational intervention of observation and its consequences as potentiality.

It is only in *this* sense that the "struggle for wholeness in physics" can be a *model* (if you desire, a "prefiguration") for the larger conflict Kepler vs. Fludd. Personal is *not* the opposite of objective! What I mean by the "objective significance of the counter position to the natural sciences" is an opposition to *private*. For example, a call to an institution of higher education is personal, but not private. That which is *personal* can also be *of interest for everyone, for the universality, for the public*. This is what the dreams under discussion appear to me to be emphasizing and *this* is what I have designated as "objective". The position which stands in opposition to the natural sciences is thus *not private*, it may well be *personal*. Actually, every feeling is personal, even if feeling is as widespread as thinking. Perhaps "personality" is specifically this unique irrational intervention in the phenomena, which can only be expressed in "objective" description of natural science symbolically, as a possibility.

The only thing I wanted to say in the Kepler article was the following: in its struggle for wholeness modern physics gives a model for the unification of opposites (Conjunctio). *The problem of Kepler vs. Fludd has re-emerged to the surface today as a conflict and it demands a Conjunctio, both in the world of ideas and in the life of concrete personalities.*

I myself would be pleased to find out more about this "larger" Conjunctio ("larger" compared with the one between wave and particle). But the "model in miniature", within the framework of quantum physics was, I believe, the best thing that I could say about it in the article.

Perhaps we could say: (non-classical) natural science is a rational, objective, symbolic description of the *possibilities* of the unique¹. The counter position is the irrational *actuality* of the unique itself.

The dreams seem to say: the effect of the last-mentioned is significant for the general public. It is as though the irrational actuality of the unique were in my case *held back* too strongly from the public *in advance*; the dreams appear to be a *compensation* for this.

Furthermore it is interesting for me that in the initial stages of natural science the Trinity stepped down from heaven in a certain sense, specifically into nature (but *not* in *people*?!). That is how I have actually understood Kepler's sphere and his "tendency towards a cult of the sun" (as B. Russell and others have expressed it). (In this connection Giordano Bruno is also instructive. The specific logical consequence of this change is pantheism, still avoided, however, by Kepler with the help of the idea of "signatura rerum".)

It appears to me that in the early Renaissance the *darkness*² which had been suppressed by Christianity wanted to become free (not, however, in Neoplatonism), but that which followed in the 17th century (from Galileo to Descartes) was, on the contrary, the expansion of the realm of the luminous God into the newly recognized order of nature (illuminated by causality).

Today we are once again confronted by darkness, evil, and the acausal, that is to say, by that which resists ordering into regularities. For me *Bohr* remains *the* thinker who made the counter position to "crystal clear" Platonism comprehensible. He taught me (as early as the 1920's) to recognize the pair of opposites "clarity - truth", as well as the pair of opposites "instinct - reason" (as he called it; it was in connection with Schmidt's experiments concerning the migration of eels), and he *always* showed us how the actuality of the unique (whether it be of observation or of individual life) at any time restricts the utility and extension of *one* of the two elements of a pair of opposites at the expense of the other, how for this reason every philosophy *must* begin with a paradox! (Recently Plato's *The Republic* has been criticized by English writers - by Scherrington, I believe - as fascist humbug and, it appears to me, not without some justification.)

¹ On the other hand Einstein: "Physics is the description of the real" and with regard to me he once added the sarcastic remark: "Or would you like to say that physics is the description of that which one only imagines to oneself?" - And Einstein also says "No physical theory can be made with only a 'perhaps'".

² At that time it *appeared* to be a revival of antiquity, but much time had passed in the meantime and neither was the darkness represented by old Dionysus any more.

Mysticism seeks the unity of all external things and the unity of the inner part of man with them as it seeks to comprehend the multiplicity of things as illusion, as something unreal. In this manner the unity of man with Divinity comes into being stage by stage, in China Tao, in India Samadhi or the Buddhist Nirvana. The last mentioned states of being are, seen from an occidental perspective, probably identical with the dissolution of consciousness of the ego. The consistent mysticism does not ask: "why?", it asks "How can man avoid evil, the sufferings of this horrible, threatening world, how can it be recognized as illusion, how can the last reality, the Brahman, the One, the Divine (which in Master Eckhart is no longer personal) be comprehended?" In contrast to this it is scientific and occidental, in a certain sense one might say Greek, to ask, for example: "Why is the One reflected in the many? What is the thing that reflects, and

what is it that is reflected? Why has the One not remained by itself? What causes the so-called illusion?" --- I believe that it is the fate of the West to again and again link these two basic positions with one another, the one which is critically rational and desires to know, and the one which is mystically irrational and searches for the absolving experience of unity. *Both* positions will always live in the human soul and one will always already carry the other as the germ of its opposite. This results in a kind of dialectic process, one about which we do not know where it will lead. I believe, as representatives of occidental culture we must entrust ourselves to this process and recognize the pair of opposites as complementary; we cannot and do not want to sacrifice the consciousness of the self which observes the world, but we can also accept intellectually the experience of unity as a type of borderline case or ideal borderline concept. If we allow the tension of the opposites to be maintained we also have to recognize that in every path of recognition or solution we depend on factors which are outside of our control and which religious language has always designated as mercy.

Before *Democritus*, who tended towards rationality, *Pythagoras* (approx. 530 B.C.), who has already been mentioned, was an influential figure. Together with his students he established a definitely mystical doctrine of salvation which was linked to mathematical thinking down to its most detailed point and which had its basis in the more ancient Babylonian mysticism of numbers. For him and the Pythagoreans everywhere numbers are to be found there is also the soul, the expression of the unity which is God. Relationships based on integers such as those which occur in the proportions of the frequency of vibration in simple musical intervals are harmony, that is to say, that which provides opposites with unity; as a part of mathematics numbers also belong to an abstract, supersensory eternal world which cannot be comprehended with the senses but rather only contemplatively with the intellect. In this way the Pythagoreans intimately link mathematics and contemplative meditation (the original meaning of "theoria") to one another; for them mathematical knowledge and wisdom (sophia) cannot be separated. The tetractys, the number four, had a special meaning and one of the oaths of the Pythagoreans has come down to us: "By the one who has given our souls the tetractys, the original source and the root of eternal nature".

As a reaction against the rationalism of the atomists *Plato* (428-348 B.C.) took over many mystical elements of the Pythagoreans in his doctrine of ideas. He shares with them his higher evaluation of contemplation compared with normal sensory experience as well as his passionate interest in mathematics, particularly in geometry with its ideal

objects. The discoveries of his friend *Theaitetos* concerning incommensurable (ratios incapable of being represented by rational fractions) segments made a deep impression on him. Here, indeed, we encounter an essential question which cannot be resolved by sensory perception but rather only by the process of thought.

In the further elaboration of Pythagorean doctrines Plato's mysticism is a light one in which understanding in its various degrees, from opinion (doxa) through geometrical knowledge (diania) up to the highest recognition of the general and necessary truths (episteme), has found its place. The mysticism is so light that it ignores many areas of darkness, something which we of today are neither allowed nor able to do. This is expressed, to give an example, in Plato's conception of the good as being identical with the highest "reality" recognizable in meditation. *Socrates'* thesis that virtue could be taught and that ignorance was the sole cause of evil deeds becomes *Plato's* doctrine of the identity of the idea of the good with the cause of the knowledge of truth and science.

While this doctrine developed rationally into the axiomatic system of geometry in *Euclid's Elements* (approx. 300 B.C.) which for so long withstood all criticism, undergoing a major revision only during the 19th century, Neoplatonism, which was given its relatively systematic formulation in *Plotinus* (204 - 270 A.D.), derives from *Plato's* mystical side. Here we find the identity of the good with the comprehensible taken to an extreme, as compared with *Plato* himself, and coarsened by the doctrine that matter (hyle) is just a lack (privatio) of ideas, that it is additionally evil with this consequently being a simple privatio boni, the lack of the good, that which cannot be the object of conceptual thought. This resulted in a quite bizarre mixture of the ethical pair of opposites "good - evil" with the naturalistic or logical "being - not being" which we see reflected in its most genuine form as "rational - irrational".

More than did other philosophical trends in late classical antiquity Neoplatonism demonstrated itself as suitable to be accepted into early Christian theology. Actually, before his conversion to Christianity *Augustine* was a Neoplatonist and since then there has always been a greater or lesser number of Platonist philosophers among Christian thinkers.

One of the general phenomena of the 17th century is the reinstatement of new barriers between the individual disciplines and faculties, and the division of the view of the world into a rational and a religious side. This

dissociation was unavoidable and it is reflected both in the philosophy of *Descartes* and in Newton's theological writings with particular clarity.

The second attempt to arrive at a synthesis between the way of salvation with gnostic-mythical elements and scientific knowledge, that of alchemy and hermetic philosophy, suffered also at this time a similar fate. It originated in classical times and, after the appearance of the *Hermes Trismegistos* it became quite widespread in the late classical period, and, after first having been fed by Arabic sources and their Latin translations, it pervaded the entire Medieval period, only to finally collapse towards the end of the 17th century with the beginning of modern natural science, after having enjoyed a period of extreme popularity during the 16th century. This time, too, the basis of the synthesis demonstrated itself to be too narrow and the pair of opposites again became dissociated: on the one side it became scientific chemistry, on the other it became religious mysticism, such as that represented e.g. by *Jacob Böhme*, again totally separated from the material processes.

The prerequisites for an alchemist philosophy initially strike us as being quite alien, but they accomplish a certain symmetry between matter and spirit. This results in a counterweight to the one-sided spiritualizing tendency which Neoplatonism, in contrast to *Plato* himself, has considerably strengthened and which was taken over by Christianity. In contrast to the Neoplatonic identification of matter with evil, in accordance with the alchemistic conception a spirit which awaits its liberation resides in matter. The alchemistic laboratory worker is always incorporated in the course of a natural process in such a manner that the real or putative chemical reactions in the retort are mystically identified with the psychic processes taking place in him himself and indicated with the same words. For us today the identification of each of the seven planets with one of the seven metals seems strange, this including the identity of *Hermes* both with the planet Mercury and with the *argentum vivum*, quicksilver, which has also retained its name mercury. A further example of the identifications which have survived is that of easily vaporizing, liquid substances with spirit, manifested as the appellation *spiritus* for alcohol, also the essence (substance) for the material result of distillation. The way of salvation, it itself also symbolized by *Hermes*, is an *opus* which begins with blackness (*nigredo* or *melancholia*) and ends with the production of the *lapis sapientium*, the philosopher's stone, which, as the *filius philosophorum* and the *filus macrocosmi*, is paralleled to Christ, the *filius microcosmi*. The release of matter by humans which transform it, this reaching its highest point in the production of the stone, is, according to the alchemistic view, a consequence of the mystical correspondence of macrocosmos and

microcosmos and identical with transformation through the *opus* which redeems man and which can only be done successfully 'Deo concedente'.

In alchemy we are confronted with a psychophysical monism expressed in a unified language which strikes us as strange and which remains suspended in the concretely visible. We may not however, simply identify the general attitude of man to nature oriented towards an experience of unity and expressed by alchemy with its outgrowths, one of which, as is well known, was an always futile and often deceptive attempt to make gold.

Goethe's views concerning natural science, so often opposed to those held by official science, become more understandable in the light of their alchemistic models, the terminology of which is revealed quite openly, particularly in *Faust*. For *Goethe* the experience of unity - "nothing is inside, nothing is outside, since what is inside, is outside" - was a more accessible type of feeling than critical natural science, and only alchemy accommodated his posture with respect to feelings in this connection. This is the background of *Goethe's* clash with *Newton*, about which a considerable amount has already been written. Less well known is the older controversy between *Kepler*, as representative of the recently evolved natural science, and the English physician *Robert Fludd*, a member of the Rosicrucians and a representative of the hermetic tradition. I believe that with respect to *Kepler - Fludd* and *Newton - Goethe* one can justifiably apply the old proverb: "What the older generation sang, the younger one twitters".

On the basis of the psychology of the unconscious *C.G.Jung* has recently made an attempt to dig up the psychological content of the old alchemistic texts and make them accessible to us. I hope that this will result in some valuable material being still brought to light, specifically concerning the role of pairs of opposites in the alchemistic *opus*. For the psychology of the unconscious, as well, alchemy signifies a counterweight to the too strong spiritualization and its confrontation with matter and the rest of natural science.

Here the question is asked which is essential for the natural science of our time: "Will we be able to realize alchemy's old psychophysical dream of unity by creating a unified conceptual basis for the natural scientific recording of the physical as well as the psychological?" We do not yet know the answer. Many fundamental questions of biology, particularly the relationship between the causal and the purposeful, and with that also the psychophysical connections, have, in my opinion, yet to be given a really satisfactory answer or explanation.

According to the formulations of *Niels Bohr* contemporary quantum physics has likewise come up against complementary pairs of opposites in its atomic objects such as particle - wave, position - momentum, and it

must bear the freedom of the observer in mind when this has to select between mutually exclusive experimental procedures which intervene in the course of nature in a manner which cannot be predicted in advance. For the observer in contemporary physics as well, once the experimental procedure has been chosen, the objective result of the observation is no longer accessible to his influence. This situation, which is not easy for the layman to understand, has been explained by various physicists in other places, and here I can only make brief reference to it:

The old issue of whether in some circumstances the psychical state of the observer can influence the external material course of nature finds no place in contemporary physics. For the alchemists of the past the answer was quite evidently affirmative. In the past century a mind as critical as the philosopher *Arthur Schopenhauer*, an excellent authority on and admirer of *Kant*, stated in his essay "Animal magnetism and magic" that he considered so-called magic effects to be quite possible, interpreting them in his special terminology as "direct effects of the will which penetrates the barriers of space and time". To that it can scarcely be maintained that *a priori* philosophical reasons would suffice to refute such possibilities beforehand. In our time there is an empirical parapsychology which raises the claim of an exact scientificity and which uses, on the one hand, modern experimental methods and, on the other, modern mathematical statistics. If the positive results in the still controversial area of "extrasensory perception" (ESP) would definitely turn out to be reliable this could lead to developments which today can by no means still be overlooked.

In the light of our historical review which has, already for external reasons, been excessively dense, we can say that today we have once again reached a point where the rationalistic attitude will be felt to have exceeded its peak and be too restrictive. Outside all opposites appear to have become extraordinarily aggravated. The rational indeed leads, on the one hand, to the acceptance of a reality which is not directly perceptible by the senses but can be comprehended using mathematical or other symbols as, for example, the atom or the unconscious. The visible effects of this abstract reality are, however, on the other hand, as concrete as atomic explosions and by no means necessarily good, but rather occasionally the extreme opposite. A flight from the purely rational, in which the will for power is never totally absent in the background, to its opposite, for example, to a Christian or Buddhist mysticism, is close and emotionally understandable. However, I believe that for the individual who sees narrow rationalism as having lost its persuasive power and who does not either consider the magic of a mystical attitude which experiences the external world in its distressing multiplicity as illusory to be effective enough, nothing remains but to put oneself at the mercy of these aggravated opposites and their

conflicts in one way or another. It is in just that way that the researcher, more or less consciously, can tread an inner way to salvation. Internal images, phantasies, or ideas then slowly evolve as compensation for the external situation, and they show that an approach of the poles of the pairs of opposites is possible. Having been warned by the failure of all premature attempts in intellectual history to attain unity I do not want to be so audacious as to make predictions about the future. Opposing the strict separation of the activities of the human mind into separate departments since the 17th century I, for my part, consider the imagined goal of an overcoming of the opposites, this also including a synthesis which would comprise rational understanding as well as mystic experience of unity, to be the explicit or implicit myth of our own, contemporary age.

Dear Mr. Fierz,

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Your recent letter (from the 9th) again interested me very much, particularly your "revelation" that More's dream, explicitly "should raise the last doubts that God's goodness and his providence do not contradict evil". I had only guessed from general indices that the problem of good and evil was essentially related [in More's thought]. Well, now I am very pleased that the enormous *suppression* of the "dark side", which took place at that time let itself be proven so directly. The matter now seems to be all the more important to me.

I have to admit that with respect to More's dream my sympathies are completely on the side of the two donkeys¹, and that I (in order to defend the idea of the "holy quaternity") would like very much to add still a few more blasts on the trumpet, also outside of the forest, to their screaming. These are *at the same time* supposed to be a further commentary on the theme of your last presentation before the psychology club.

¹ What More himself says about this only shows a violent suppression which the dream attempted to compensate.

1. *The counterposition of alchemy to Platonism. Fludd.*

In a manner differing from what is true of the Platonists the problem of light and dark was *not* just suppressed by the alchemists of the 17th century, and it was and continues to be what fascinates me so much in *Fludd*. Fludd is probably a contemporary (or perhaps somewhat earlier) of More (from what year are those dialogues of his which you have studied?) and I have in mind particularly his "Philosophia Moysaica" (appeared

1637) in mind as a counterpart to More. - Right in the beginning we find a polar black and white figure, under which "Dionysos" stands to the left and "Apollo" to the right. (I ask myself whether you should not *publish* this figure in your work about More - Newton. It would probably be worth it. I was unable to since it had no relation to Kepler.) As far as I remember, the same figure is to be found in Fludd's earlier work "Utriusque Cosmi ... Historia", 1621. While it is the case that in the last-mentioned there is no commentary to this figure, the Phil. Moys. contains numerous (Latin) quotes from the Old Testament, their purpose being to illustrate that God *also* brings darkness (tenebras) and has an *ominous* side. Among the quotations included is the very famous one from *Isaiah* 45, 6-7:

I am the LORD, there is no other;
I make the light, I create darkness,
author alike of prosperity and trouble.
I, the LORD, do all these things.

The Old Testament only contains the barbaric-primitive image of a capricious tyrant, but the Jewish cabbalists (who exerted a direct influence on Fludd) have always attempted to distill something more philosophical from it [in particular *Luria* with his doctrine of Tsim-Tsum (= retreat)]. At least the capricious tyrant had "no little lamb's tail" (as *Heine* allows his rabbi to say in the "Disputation").

2. *The mystical side of Plotinus. Meister Eckhardt. Negative Theology.*

This agreement of the mystics consists of the postulate of a transcendental unity of all existence, about which it is possible to make no further statements using human concepts and which is impersonal or suprapersonal, "formless", abstract and not imaginable. For Plotinus this is the "One", for Meister Eckhardt "God", *distinguished* from "the divinity" (see below). All mystics are in agreement that the human concepts "good" and "evil" do not allow themselves to be applied to this abstraction.² -- The technical term for this is "negative theology".

Plotinus speaks in this connection of the "One" that it is "hyperagathon" ("supergood") (see Plotinus VI, 9) and Meister Eckhardt says that God cannot be "good" since otherwise he could also be "better".

A learned Indian, the philosopher Radakrishnan, assured me that no significant difference exists between the Vedic doctrine and this side of Plotinus or of Meister Eckhardt. The writings of these two authors are, according to Radakrishnan, those produced in the occident which come closest to the Vedic doctrine.

I have the impression that this mystical side of *Plotinus* was (despite Meister Eckhardt) *concealed* by the Renaissance Platonists (as it also was by More), probably because it differs from the official religion of the church.

I do not see how this postulate of the mysticists can contradict any knowledge in the natural sciences, nor do I see that it is in any way in conflict with experience. I do, however, certainly see that it is also necessary to introduce forms of such an abstract reality which are expressed in more comprehensible terms to human consciousness in order to bring them closer to human understanding and human feeling. (Psychologically expressed the form of this reality which is closer to human consciousness has the "character of a *son*"). For Plotinus this is the *nous* (in Christian terms: the *son* of God), for Meister Eckhardt the divinity, for Jung the "pictures of the unconscious", in which the archetypes, the highest of which being the "self" and which, in themselves, are abstract and unimaginable, are manifested. These figures of the unconscious are actually *personal* (in contrast to the "last reality"), in India the personal "Ishvara" - and I do not see how, except with these figures of the unconscious anything else can still be personal.

Concerning the type of this psychological reality brought closer to the consciousness of man there exists the dispute between the quaternists and the Platonists (in the widest sense), and here I must criticize the Platonists (in agreement with Fludd and others).

² Correspondingly it is stated in the Taoteking, nr. 5: "Nature has no love for the human species: for it living creatures are like straw dogs". After the sacrifice these are thrown away.

3. The concept 'privatio' (στέρησις) in classical natural philosophy. Matter and evil. Criticism of Neoplatonism.

In order to prevent this letter from becoming all too long I would like only briefly to discuss these questions of the history of ideas. I encountered these questions because in Chapter V. of C.G.Jung's book *Aion* everything is left out which for me is important and interesting in the idea of 'privatio'. (Evidently it is unimportant and uninteresting for him.) There the impression is given that the *privatio boni* is an early Christian invention (in a grotesque manner Plotinus is not mentioned at all in this context!), while the opposite is true: that the concept *privatio* is very old and the doctrine of the *privatio boni* arose organically in late Platonism. But, miraculously, from my different point of departure I wind up at the same

conclusion which was reached by Jung, specifically that the idea of *privatio* is to be denied. (There for Fludd, for Jung, and for me, as for many other authors, the archetype of the *quaternity* lies in the background!)

The concept of *privatio* (στέρησις), in German *Ermangelung* 'shortage' (something which is not particularly nice), plays an important role in Aristotle's writings. He polemicizes against an already existing view of the Eleatics that *matter* is a pure *privatio of ideas*. His solution is that matter is *actu* [actually] 'not being' (νῆ ὄν), while it *potentia* [potentially] is 'being' and not simply a *privatio*. "Not being" always meaning then (I believe since *Parmenides*) something which eludes conceptual comprehension, being something about which it is "impossible to think". It *never* means that something is just not there. For example, phenomena are "not being", all change is "not being", only the unchangeable is "being" (*Parmenides* versus *Heraclitus*). Aristotle made the discovery that it is also possible to speak about *that* which a thing *becomes*; it meant progress, it originated in biology. It also provided his solution of the difference 'actu' and 'potentia'.

Plato, on the other hand, started from *geometry*. Geometrical ideas were "being". Empirical bodies consist of these ideas plus the X which distinguishes actual bodies from ideas and which Plato designates as being pure *passivo*, "receptacle", "wet nurse" for ideas. It was no longer possible to think about this X. It was Aristotle who first designated the X as *hyle*.

Evidently, the view that *hyle* (later *materia*) was only a *steresis* (*privatio*) of ideas had already established itself at the older Platonic Academy (in association with the Eleatics); in *Plato* the word *privatio* is not encountered at all.

Now, ever since Socrates there has prevailed a *rationalist conception of the good* (learnability of virtue, etc.). The good alone could be conceptually grasped, the good *theos* is the "One" *idea* from which emanated all other ideas, particularly the geometrical ones. The good *theos* was also recognized in Euclidian geometry. *Theos* was not the only thing present, but it was the only thing about which it was "possible to think".

For this reason *hyle* in later Platonism becomes to be more and more identified with the ugly and the evil.³ Neither was it possible to think about the evil, it was "not being" - *for things of this type we say 'irrational'*, only the good was being. For this reason the following is valid in *Neoplatonism*:

*The evil = matter (hyle), is 'not being',
it is only a privatio of the good (of the 'idea')*

That is *simultaneously* a doctrine of natural philosophy *and* of theology and ethics. One is impossible without the other, *if we do not believe that matter is merely a privatio of ideas then it becomes pointless to speak of the evil as only a privatio of the good.*

The doctrine is systematically presented and developed in *Plotinus* (but is in fact older), and it was taken over by *St. Augustine* and the other early Christians with a Greek education en bloc. Instead of saying 'the one' (τὸ ἓν) they said 'God', and since in *Plotinus* τὸ ἓν and τὸ ἄγαθόν (the good) become expressly 'one and the same' (the 'hyperagathon' appears in Plotinus' other writings, there he seems to me to be so *inconsistent!*), so God was 'good'.

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The only way I can understand this Neoplatonic doctrine is that the good is the rational, and the evil the irrational.

But the whole, a very *vulgarized* Plato, is extremely weakly justified. Today we only no longer believe that scientific knowledge or the rational are 'only good' (see the applications of atomic physics), but additionally, as early as in late antiquity there were already other philosophical doctrines competing with and opposed to Neoplatonism. There was indeed everything materializing, as was the case with the Atomists, Epicureans, and the Stoics who expressly taught that matter is completely indifferent with respect to good and evil, then there was the Peripatetic tradition which rests on Aristotle who has already been mentioned, then there were also the alchemists with the 'Hermes Trismegistos' which have links both to Aristotle and to Plato's 'Timaeus'.⁴ None of these other philosophical trends of the late classical period use the concept of *privatio* at all. And the alchemists said that not only was matter real, but also that "a spirit resided in it".

So Fludd can also look back on a long tradition (his terminology is strongly Aristotelian) and the "trumpeting" donkeys seem to be well founded!

³ The philologist H. R. Schwyzer, who has recently been working on a new edition of Plotinus was kind enough to provide me with a few references about it.

⁴ There was also the strong gnostic opposition to Plotinus' doctrine of the evil of which he never ceases to speak (in contrast to which he never mentions the Christians)!

4. *Final remarks on the dissociative character of the intellectual situation in the 17th century and about More-Bathynous' dream.*

Now I see somewhat more clearly how the misunderstanding concerning the 'little lamb's tail' gradually arose in the image of God - this development in intellectual history looks like biological evolution according to Darwin - and how More-Bathynous desperately clung with his consciousness on this little lamb's tail. On the one hand the problem points back to the Old testament, on the other, it points forward to a 'problem of west and east', of which the 17th century did not yet have a premonition (it was only in 1801 that Duperron let a Latin translation of the Upanishads be printed at the Paris Academy), and which also served as a starting point for Schopenhauer. For me, however, there is no doubt (likewise as for Fludd and Jung) that only the mutants of the *image* of God with no little lamb's tails have a chance of surviving the struggle for intellectual existence.

In the 17th century Fludd was archaic, unoriginal, a fossil, and everything seemed to be against him. The situation was *dissociative* which is also evident in Boehme's pictures and Descartes' philosophy. What in Descartes is the split into extension and thinking is in More's dream *the split of 12 into 2×6* . This split makes the quaternity impossible. The natural *division of 12 would have been into 3×4* , this also corresponding to the old division of the zodiac (about which Fludd also never ceases to speak).

But the time was not ripe for a quaternary view of the world, and the dark half receded back into the unconscious. *We* are the first ones to again begin reading under the opaque blue coloring of the covering the features of a writing which again brings us closer to Fludd's manner of thinking, according to which the "child of the sun" can only arise in the *middle* sphere.

122 I have previously read Fierz's essay for the first time. (I arrived in Zurich on April 11.)

April 18

Dream. I see an English text in front of me. (I could no longer recall its words when I awoke). Beneath this text there are, however, other words to which special arrows on the paper point. (These arrows were probably supposed to draw my attention *away* from the English text to that second text). These other words seem "secret" to me. They say:

"Today the sun will demonstrate itself to be as effective as it was during Kepler's time."

Now there is a man with a superior air standing next to me, an "old sage", a "master". I ask him if these secret words are those of *Newton*. But the master answers me with a clear, firm voice:

"They are those of Chancellor Regiomontanus!"

Then I awaken. (NB. By "chancellor" I understood in any case, a government official.)

When I awaken *Müller of Königsberg* comes to my mind as Regiomontanus. He was surely close to being Newton's contemporary. I certainly had to find out what he wrote. When dreaming I frequently have such "cryptomnesias".

By him who emplanted the number four in our spirit, the source and root 125
of ever-flowing creation.

When I began to occupy myself with Kepler's image of the trinity I did 129
not yet know of Fludd's polemics, and even less that the number four has such an essential spiritual meaning for him (the relevant longer passage is printed and translated in my work) - I only knew that for Kepler the Pythagorean tetractys, with which he was probably familiar, had *no* symbolic meaning. Thus, on the psychological line this time I have *once again* bumped into the problem of the transition from three to four. In neither case was it by any means Mr. C.G.Jung who suggested it to me, nor was there an advance conscious intention down. Consequently I am rather certain that *objectively* there is an important psychological and, perhaps, natural philosophical problem connected with these numbers.

Then to the problem of opposites: now in physics there exist
compensatory pairs of opposites (represented by positive and negative quantities, such as the two electronic charges) and *complementary pairs of opposites* (represented by quantities which cannot be interchanged such as *p* and *q*). That is a very important distinction since it is my personal view that they have a psychological counterpart: *good* and *evil* seem to me - as they do to you - to be a compensatory pair of opposites, but *known* - *unknown* (Chinese has the corresponding *yang* and *yin*), a complementary pair of opposites. In my view analytical psychology suffers greatly, since it lacks this distinction (which has something to do with its representatives having insufficient training in mathematics and the natural sciences). *See below*. I would be very pleased if you would, in a completely schoolteacher-like way, insist on this conceptual differentiation in

your essay. This matter now brings me to another one which was also treated in your essay: the difficulties with the field concept which result from matters of principle. You presented the "regulation" for the reality of the field very nicely on page 14: "But Faraday thought that the field must be present, whether we prove it or not, exactly in the way, as we believe, that man exists, whether we look at him or not." The further addition can be made that: "exactly as we assume that the movement of the moon is the same, whether we observe it or not" (which goes considerably beyond its mere existence)¹. That is naturally the entire snag, with respect to both physics (*quantized* field theory) and the psychological analogy.

I am of a somewhat different opinion than you in that I do not ascribe the same significance to the impossibility of empty space in quantized field theory as you do. In my opinion the snag in quantized field theory nevertheless remains *quite the same* as in non-quantized classical field theory: it should be the case that a field would not be mathematically or logically *conceivable* without the experimental bodies required for its measurement. In actual fact, however, it is like this in the present theory: if we take $e=0$, thus describing light fields, then these, whether classical fields or photons, are mathematically possible *without* charges; if we take $e\neq 0$ and describe electrons, positrons and photons (Schwinger), this is mathematically possible *without* the heavy masses which are a part of the measuring devices which are needed in order to obtain a measurement of the fields or density of charge in small spaces (of the order h/mc , m =electron mass). The true relation of complementarity between the possibility of perceiving the *same* physical objects, either as fields or as experimental bodies (measuring devices) (the first case after *other* objects function as measuring devices) is not expressed in the formalism used today. (NB. Of what use is it to me that *no* empty space is possible?)

¹ I might name that "the classical idea of objective reality in the cosmos".

- 134 Momentarily it appears so difficult for me to find *anything* - I mean an *activity* - which permits itself to *continue*. The events of the last year (including the discussions which I had within physics) all appear to me be just now of such a type that they do *not* permit themselves to continue. Where leads the road?

It is my momentary impression that I am only *apparently* traveling to the U.S.A. Let us see how it will continue.

With quaternary greetings
Your
W. Pauli

If I have understood him correctly (perhaps you could have him elaborate his viewpoint to you *directly*) he thinks I have only made a lazy compromise between the two elements of the pair of opposites, that to him my entire attitude tastes strongly of a doctrine of salvation, and that the pair of opposites will never be able to come together since, in his opinion, "the waters" *sub specie aeternitatis* are "too deep" for this. 135

Now, however, such things as the dream you have quoted seem to speak against such a skepticism (the presentation was written down much earlier than the dream): I know *that for me the "motivating forces" of both scientific understanding and religious feeling are the same*. And that is precisely what the dream in question expresses. Expressed in Jungian fashion the "motivating force" is the *dynamis* or power of the archetype, and the "constellated" archetype is the "conjunctio"! This takes place in the "new house", in the "church". It would thus be a matter of communicating this experience to others (it seems to me that for Jost this did not succeed). When one descends sufficiently deep into the nether world then - at the stream of life (Styx) itself - the pair of opposites must fade. That is also something I wanted to say already in the paper I delivered at Mainz. The word "conjunctio" is not mentioned there (but alchemy is mentioned).

If I am now supposed to say what the "secret writing" means for *us* 135
 moderns I would like to interpret the *dark* as that which, for the time being, eludes intellectual, regular (= "light") order. That is the *evil* in ethics (the problem of the integration of the evil in the divinity, etc.), the *acausal* in natural philosophy. However, the degree to which the acausal is "blind" chance, that is to say, also lacks a *purposeful* sense (as is the case in quantum mechanics), is still open. We might be approaching the knowledge of a new type of entity both in parapsychology (this appears during the 17th century as an "apparition" in Descartes' dream) and in biology. (Specifically, it seems implausible to me that in our understanding of biological evolution it will always suffice to have "blind" *chance* as the selective factor - as the Neo-Darwinists want to do. Should not external conditions and mutations (major changes in the genes) there occasionally have formed an *indivisible* (that is to say integral) phenomenon?) The "vital" could have reference to *both* of these areas (parapsychology and biology).

It was the 17th century which specifically witnessed the period when the "acausal" (in Protestantism also the evil) disappeared once again into the unconscious after the success of modern natural science. The "light" order appeared to extend to nature (consider Giordano Bruno's pantheism) and the well-known split between religion and natural science began.

Now I am excited to hear your reaction!

Always yours
W. Pauli

136 If I now attempt once again to remember those spontaneous products of my phantasy (they extend over rather long periods of time) in which this theme occurred, they appear to me as being "meaningful" or "significant" even again as remembrances. As though it were to be a matter of a developmental line which, although only required from me as an individual, would nevertheless be of importance for the *entire culture* as a further elaboration of that which has gone before and is linked to the past in our *occidental* world.

When I began to talk to you about this matter I did it under the instinctive prerequisite that similar problems might also be of acute importance for you. (---) The fact that you have entered the discussion so quickly and so thoroughly speaks for the correctness of this assumption.

140 Within the next few days a copy of the volume will be sent to you containing C.G.Jung's work on synchronicity and mine on Kepler. I would like to use this opportunity not only to express my thanks once again for your various encouraging remarks, but also to provide this latest child of mine with a commentary.

The central problem which has been "constellized" here is, in my opinion, the "*psycho-physical*". I have become more and more convinced that the concept of "parallelism" elaborated on the basis of Leibniz and Spinoza is illegitimate when viewed from the standpoint of *classical physics* and was obtained by "devious" means (see pg. 169; as well as C.G.Jung, pg. 91). Because if everything is to be deterministically causal there is, in my opinion, no place for another type of connection which would preferably be designated as something like "parallel", instead of "causal". Therefore the presence of the intellectual cloud of fog which has been christened "psycho-physical parallelism" is similarly a reference to the imperfection of the classical-scientific picture of the world, as, for example, the photoelectric effect and the quantum of action. For this reason it is more satisfactory for me to think that the *acausal* type of connection, which was called the "psycho-physical parallelism", must *also* exist otherwise as "mutual connections" or, respectively, as "correspondence" and not only as something in the psycho-physis.

C.G.Jung has tried to bring the connection psycho-physis into contact with his "synchronicity" phenomenon (abbreviated Σ) (see footnote 2), pg.

85/86). But that resulted in a difficulty of principle to which I have expressly referred and which Jung (pg. 103-104) has expressly taken into consideration: the synchronicity (Σ) phenomena which he observes do, in a narrower sense, elude capture as "laws" of nature, since they are not reproducible, that is to say, they are unique and *obliterated* by the statistics of large numbers. In physics, on the other hand, "acausalities" first become *comducible*, that is to say, always present are, furthermore, not only all psycho-physical connections but also such empirical facts as the sense of distance possessed by many animals (migratory birds, etc.) and, in a certain sense, also the effects cited by Rhine which specifically *stand out* through statistics for large numbers (NB. Jung's astrological study in chapter II appears to me to be a complete failure).

For this reason a certain dangerous fluctuation in the comprehension of Σ phenomena may be observed in Jung's work in that one time he takes into consideration phenomena which can be reproduced, the next time phenomena which either cannot be reproduced at all or occur but rarely (NB. I would rather designate the first Σ phenomena in a narrow sense as "sense correspondences" than as " Σ ", *without* explicit emphasis on the concept of time"). For me personally it would be much nicer to begin with "acausal orderings" which are always *reproducible* (including those of quantum physics) and attempt to understand the psycho-physical connections as a special case of this general species (as, of course, N. Bohr also attempts to do).

This chapter IV in Jung's work appears to be something more than a "summary": it appears to me to be C.G. Jung's intellectual legacy, something which is pushing its way away from special "analytic psychology" into the philosophy of nature in general and the psycho-physical problem in particular.

I would be very pleased to hear your view. In the meantime all the best for Paris. I shall be in Copenhagen from the 8th to the 15th of June.

Many regards

Yours

W. Pauli

44 All of this then led me onto further, somewhat more phantastic paths of thought. It might very well be that we do not treat matter, for example viewed in the sense of *life*, "properly" if we observe it as we do in quantum mechanics, *specifically when doing so in complete ignorance of the inner state of the "observer"*.

It appears to me to be the case that the "after-effects" of observation which were ignored would *still* enter into the picture (as atomic bombs,

general anxiety, "the Oppenheimer case" e.g. etc.), but in an *unwanted form*. The well-known "incompleteness" of quantum mechanics (Einstein) is certainly an existent fact somehow-somewhere, but certainly cannot be removed by reverting to classical field physics (that is only a "neurotic misunderstanding" of Einstein), it has much more to do with *integral relationships between "inside" and "outside" which the natural science of today does not contain* (but which alchemy had suspected and which can also be detected in the symbolics of my dreams, about which I believe them specifically to be characteristic for a contemporary physicist).

With these vague courses of thought I have reached the border of that which is recognizable today, and I have even approached "magic". (From this standpoint observation in quantum mechanics might even appear to someone as a "black mass" after which the "ill-treated" matter manipulates its counter-effect against the "observer", thereby "taking its revenge", as a "shot being released from behind"). On this point I realize well that this amounts to the threatening danger of a regression into the most primitive superstition, that this would be much worse than Einstein's regressive remaining tied to classical field physics and that everything is a matter of holding onto the positive results and values of the *ratio*.

Bearing this in mind I have now taken the paper entitled "Animal magnetism and magic" written by "my" *Schopenhauer* in hand once again (it is a rather long time since I have read it). -- One would not, of course, accuse the author of a "primitive superstition". He also takes quite a critical stand to the empirical material, but he goes quite far in the recognition of the "magical effects". He even goes so far - with all the emphasis of the horror of the witch trials - to say something about "witchcraft": "Even if it was based on error and abuse in the vast majority of cases we cannot be allowed to consider our ancestors to have been completely deluded for having pursued a crime with such horrible severity which could not have even been possible." ... "In order to laugh away all secret sympathy or even magical effect one would have to find the world quite, yes, quite totally comprehensible. But one can only do that by looking into it with a completely flat view, a view which does not even permit the idea that we have been sunk into a sea of riddles and incomprehensibilities and can know and understand completely neither the things that we live with nor ourselves.

However, the interesting thing for us is that Schopenhauer regards these "magical" effects precisely as *empirical verification of his philosophy*! One would (according to Kant) have to distinguish specifically between "the phenomena" and the "thing- in-itself", and the latter would be just "the will" as well as also "our own inner selves". In addition to the "nexus physicus" there would be yet an additional connection between the

phenomena of this world, a "connection" which "goes through the real essence of all things" and is "as if subterranean", the "nexus metaphysicus"..." As we causally appear to be *natura naturata*" so are we "also probably capable of an influence as *natura naturans*" which could even break through the "principium individuationis" (= space and time, see above) -- for instance: the unity breaks through the multiplicity. And all of this should, in Schopenhauer's opinion, spring forth from "the inner feeling of the omnipotence of the will itself". According to Schopenhauer there exists "a *direct influence* of the *essence of things themselves*, that is to say from inside on nature", while "the law of causality is only the bond of phenomena".

The Jungian school would speak of the "collective unconscious" rather than of "the essence of things themselves", of something like "the stream of archetypes in its relation to consciousness which follows a drop in energy" rather than of the "will", of "psychologicus" rather than of "metaphysicus".

In quantum mechanics the physicist becomes aware for the first time that he is now also playing "*natura naturans*"¹ -- no wonder that it goes wrong the first time -- since "all beginnings are difficult".

One of my excuses for the length of this letter to you is that you (in your letter of the 20th of May) released all of these courses of thought (are they day or night thoughts?) in me as an attempt to grasp an experiencing of our contemporary physics, which is for me intimately familiar and instinctively emotional, from the perspective of natural philosophy as well.

In this sense many greetings
Always your
W. Pauli

¹ I remember that we spoke about the terms "*natura naturans*" and "*natura naturata*" once long ago because they appeared in a dream of mine. At that time we also discovered that these terms were quite current during the Middle Ages and appear in the writings of both *Averroes* and *Nicolaus Cusanus*, much later in *Spinoza* as well. I am now sure that my dream of then was a *cryptomnesia* from this article by *Schopenhauer*.

That which I have in mind with respect to the new idea of reality I would like to preliminarily name: *the idea of the reality of the symbol*. 151

When the layman says "reality" he usually thinks that he is speaking about something which is self-evidently known; while to me it appears to 153

be specifically the most important and extremely difficult task of our time to work on the elaboration of a new idea of reality. This is also what I mean when I always emphasize that science and religion *must* have something to do with one another.

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Beyond the atom

K. V. Laurikainen: *Beyond the Atom*

The Austrian physicist Wolfgang Pauli (1900–1958) is often called “the conscience of physics”. He was famous for his sharp and critical mind which made him a central figure among the founders of quantum physics. To a lesser extent it is known that he also was an outstanding philosopher, especially interested in finding a new conception of reality and of causality. A careful study of the original sources of the past culminated in his study of Kepler and of medieval symbolism, a concept that played a central role in his discussion with C.G. Jung on the “psycho-physical problem”. Pauli considered in particular the sharp distinctions between knowledge and faith and between spirit and matter as dangerous. Rather they should complement each other in our comprehension of reality. Professor Laurikainen tries for the first time to describe in detail Pauli’s ideas. His book is based on the large and as yet unpublished correspondence between Pauli and M. Fierz. Its careful analysis adds depth and clarity to the few publications by Pauli on the above mentioned problems and explains why Pauli grasped the meaning of atomic theory more deeply than even N. Bohr himself. The book should be of interest both to philosophers and to physicists and should encourage further studies on the humanist W. Pauli and his contribution to our understanding of reality. But also the laymen pondering over the conception of reality in science will take advantage of this text.

